

UNIVERSITY OF BRISTOL.



THE ANNUAL REPORT

OF THE

Agricultural and Horticultural
Research Station

(THE NATIONAL FRUIT AND CIDER INSTITUTE)

LONG ASHTON, BRISTOL,
1931.

BATH:

PRINTED AT THE CHRONICLE AND HERALD PRESS, WEST GATE.



Digitized by the Internet Archive
in 2025

AGRICULTURAL COMMITTEE, 1931-32.

Appointed by the Ministry of Agriculture and Fisheries.

RAYMOND G. W. BUSH, Esq., Bell's Castle, Kemerton, Tewkesbury.

Appointed by the National Fruit and Cider Institute.

C. P. ACKERS, Esq., Huntley Manor, Gloucester.

HIATT C. BAKER, Esq., LL.D., Oaklands, Almondsbury, Glos.

JOHN W. PULLIN, Esq., Spaniorum Farm, Compton Greenfield, near Bristol.

H. V. TAYLOR, Esq., (Horticultural Commissioner), Ministry of Agriculture and Fisheries, 10, Whitehall Place, London, S.W.1.

H. B. NAPIER, Esq., J.P., Long Ashton, Bristol.

MAJOR E. W. FARWELL, Kilmersdon, near Bath.

J. H. WOOTTON, Esq., Byford, Bridge Sollers, Hereford.

Appointed by Senate of the University of Bristol.

PROFESSOR B. T. P. BARKER, M.A., Professor of Agricultural Biology in the University.

PROFESSOR O. V. DARBISHIRE, M.A., Ph.D., Professor of Botany in the University.

PROFESSOR W. E. GARNER, M.Sc., D.Sc., Professor of Physical Chemistry in the University.

R. BOUTFLOUR, Esq., M.Sc., Reader in Agriculture in the University.

Appointed by the Council of the University of Bristol.

THE VICE-CHANCELLOR (T. LOVEDAY, Esq., M.A., LL.D.) (*Chairman*), The University, Bristol.

STANLEY H. BADOCK, Esq., J.P., LL.D. (Treasurer of the University), Holmwood, Westbury-on-Trym.

ANDREW HAGGARD, Esq., The Hilltop Fruit Farm, Ledbury, Herefordshire.

F. PAGET NORBURY, Esq., J.P., Sherridge, near Malvern.

MAJOR F. W. B. CRIPPS, Ampney Park, Cirencester.

Appointed by the Gloucestershire County Council.

H. MATTHEWS, Esq., J.P., Down Farm, Winterbourne, Glos.

Appointed by the Somerset County Council.

CAPT. W. D. M. WILLS, Barleywood, Wrington, Somerset.

Appointed by the Wiltshire County Council.

RICHARD STRATTON, Esq., Kingston Deverill, near Bath.

Secretary.

THE SECRETARY AND REGISTRAR OF THE UNIVERSITY.
(MISS W. SHAPLAND.)

CONTENTS—*contd.*

	PAGE
Progress Report on Vegetable Diseases—III	119
<i>L. Ogilvie</i> <i>and B. O. Mulligan</i>	
Notes on the Rusts of Basket Willows and their Control ..	133
<i>L. Ogilvie</i>	
Observations on Hop Diseases in Herefordshire and Worcester- shire with suggestions for their Control ..	139
<i>L. Ogilvie</i>	
CIDER AND FRUIT PRODUCTS :—	
Cider Making Trials for the Season 1930-31	143
<i>O. Grove</i>	
The Improvement of Farm-made Cider ..	158
<i>P. T. H. Pickford</i>	
The Clarification of Cider by the Centrifuge Method—II	168
<i>O. Grove</i>	
The Effect of Storage Temperature on Cider—III ..	171
<i>O. Grove</i>	
Cider Making Trials with Apples from British Columbia	174
<i>O. Grove</i>	
The Domestic Preservation of Fruit and Vegetables :	
Progress Report, 1926-1931	177
<i>Margaret L. Adams</i>	
WILLOW CULTURE :—	
The Value of Young Bat Willow Trees ..	185
<i>H. P. Hutchinson</i>	
ADVISORY AND EDUCATIONAL SECTION :—	
Report on Advisory Work, 1930-31	187
PUBLICATIONS DURING 1931	
	202

INTRODUCTION.

BY B. T. P. BARKER, DIRECTOR.

After the exceptional number of conferences and other occurrences of unusual character recorded in last year's Report, which combined to interfere with normal working conditions during 1930, it was expected that the work of the Department during the year following would proceed with little interruption by outside calls. For various reasons, however, 1931 also has been a year of unsettlement, and most sections of the Department have been affected at one time or another, as will be seen from the record of events of the year which follows.

The changes in arrangements at the Agricultural Advisory Centre at Berkeley Square, Bristol, brought about by the departure of Professor Hanley, and at the Campden Research Station, in consequence of the new scheme now in force there, have been effected without undue disturbance of the work in hand. At both places steady progress has been made under the new conditions. The Long Ashton Station, on the other hand, has not been able to avoid considerable unsettlement in consequence of staff changes, absence of staff through outside calls, and additions and alterations to the laboratory building.

There has been, to a larger extent than usual, a demand on the time of the staff of the Department in connection with educational exhibits provided at shows. This was inevitable owing to the holding of the Bath and West Show for the year at Ashton Court. An exhibit of considerably greater magnitude than usual was provided by the Department, and both its preparation beforehand and its demonstration at the time of the Show involved an extensive call on the services of the staff.

From August onwards, the financial crisis through which the country is passing has naturally not been without effect on the Department. The reduction of Government and County Council grants has rendered unavoidable a reduction of its commitments and programme of activities. While it is hoped to be able to carry on without drastic alterations during the current financial year, there is ground for serious anxiety for the future. To refer to one matter in particular, the five-year period for which the substantial grant from the Empire Marketing Board was made to Long Ashton

for its investigations on the factors governing fruit quality comes to an end next July. At the time of writing, there is little prospect of the renewal of this grant, even in a reduced form. Consequently, although this line of research is yielding results of high practical value and has reached a stage full of promise for further results of even greater importance, it is feared that the team of workers engaged on the subject may have to be disbanded and the work suspended. Just at this time, when the future of commercial fruit culture in this country is so largely bound up with the question of improvement of quality, the cessation of this work, which has secured world-wide recognition, would be deplorable.

THE CAMPDEN STATION.

The new scheme for this Station, under which its activities are now concerned exclusively with research and advisory work relating to the canning of fruit and vegetables in its commercial aspects, is in full working order. In the matter of financial support by firms engaged in the canning and associated industries, the response has been highly satisfactory, the subscriptions promised for the five-year period over which the present arrangement stands having exceeded the minimum sum stipulated by the Treasury many times. At the end of December 1931, the subscribing firms numbered 54.

As a consequence, the pressure of work on the very limited staff has become excessively heavy. Supplementary assistance had to be provided during the height of the canning season in 1931, but it is evident that the requirements of the situation should be met by the appointment of an additional research worker on the permanent staff. This matter is now under consideration and it is hoped that the financial resources of the Station will permit of this much-needed development.

The amount of time which has had to be spent by the staff away from the Station on advisory work has made it impossible for any regular series of courses of instruction to be organised. Short periods of study have been spent at the Station by a few individual students, including Mr. K. T. Rae, of the Agricultural Department of Grenada, and Mr. A. C. Shill, of the Department of Agriculture of Dominica, for whom arrangements during their stay in this country were made at the request of the Ministry of Agriculture.

Although, nominally, the Campden scheme is limited in its scope to the canning of horticultural produce, some attention has necessarily been given to more generalised questions, such for example as problems concerned with can-making and the lacquering of cans. An extension of the field of work still further and touching

other kinds of canned produce must sooner or later come up for consideration when the staff is strengthened, for many requests for advice and investigation in those directions are being received and there is no provision elsewhere for the kind of assistance required.

THE BERKELEY SQUARE ADVISORY CENTRE.

Since the departure of Professor Hanley in February 1931, the work at this Centre has been under the charge of Mr. A. W. Ling, in accordance with the arrangement stated in last year's Annual Report. An account of the work during the year is contained in a later part of the present Report. It shows that the expansion so marked in recent years is still continuing. In many directions there is evidence of appreciation of its value to the farmers of the Bristol Province. There has been maintained the closest co-operation with the staffs of the Agricultural Education Departments of the counties in the Province. In addition, the services of the staff and of that at Long Ashton have continued to be available for the investigations undertaken by the Experiments Committee of the Bath and West Society, of which both Mr. Ling and Dr. Wallace are members.

Among the more recent developments of the work, special attention may be called to the survey on the cost of production of strawberries which has been undertaken by the Agricultural Economics staff. The survey is proceeding in the strawberry growing areas of Herefordshire and Worcestershire and in the Cheddar district in Somerset, where the hearty co-operation of the growers has been secured.

There have been few staff changes during the year. Mr. G. G. Hayes relinquished his duties as Student Assistant in the Economics Department in September. An addition to the staff of this Department has been made by the appointment of Mr. H. T. Horsman, B.Sc., as Student Assistant. Mr. R. B. H. Round, B.Sc., whose appointment as Assistant Agricultural Chemist was recorded a year ago, began his work in February. Mr. W. D. Menzies, M.R.C.V.S., the Veterinary Advisory Officer, came into residence in May on the completion of his special course of study in France. The great demand for his services during the short time they have been available indicates how urgent was the need in the Province for the advisory assistance in this subject which this new post now provides.

The recent staff increases have necessitated the provision of increased laboratory accommodation at Berkeley Square. Vacant

rooms in the premises there have been fitted and equipped as laboratories for the veterinary work and for the grass analyses required in connection with the grassland investigations. Another room has been converted into a library and common room for the staff. An adjacent building has been altered to render it suitable for the accommodation of live animals sent to the centre for observation by the Veterinary Advisory Officer.

THE LONG ASHTON STATION.

At this Station the only staff change to be recorded has been in the post of Advisory Officer in Entomology. Mr. L. N. Staniland, A.R.C.S., D.I.C., who has held that post since 1924, accepted a corresponding appointment at Seale-Hayne College, Newton Abbot, for the South Western Advisory Province last May, and his place has been filled by Dr. H. G. H. Kearns. The latter fortunately, for some time past, while occupying the position of Lecturer in Zoology at Bristol University, has been in close touch with the entomological staff at Long Ashton. He has undertaken conjoint work with them on various problems and has thus been able to bring to his new duties some previous knowledge of the advisory problems of the Bristol Province in this subject. This advantage has proved of particular service since, owing to the serious illness of Dr. Walton, the Research Entomologist attached to the Station, during a large part of the year, coupled with Mr. Staniland's departure, the work in this subject would have been very seriously disorganised otherwise. Thanks to this and to the loan for two periods of Mr. Staniland's services by the Seale-Hayne College authorities—for which the Station is much indebted to the College—to enable him to complete his observations on certain spraying trials carried out by him earlier in the year, the effects of the absence of Dr. Walton were largely reduced.

The Station has also lost the services of Miss M. M. Walker, and Mr. K. C. Naik, M.Sc. In both cases, a year of post-graduate research work has been completed. Miss Walker has assisted Mr. Marsh in his investigations on Apple Scab, while Mr. Naik, under the supervision of Dr. Swarbrick, has carried out a piece of research related to the general problem of fruit bud formation, for which he was awarded the degree of M.Sc. by the University of Bristol. He has now returned to India to take up an appointment at the Lyallpur Agricultural College, Punjab.

The vacant places in the laboratory resulting from their departure have been filled by two other post-graduate workers, Prof. E. L. Proebsting, B.S., M.S., Ph.D., Department of Pomology, University

of California, and Mr. D. V. Karmarkar, M.Sc., a graduate of Bombay University, from the Indian Institute of Science, Bangalore. Professor Proebsting, who is spending several months of his year of study leave, under a Fellowship of the U.S.A. National Research Council, at the Station, has of late years been carrying out investigations concerning mineral nutritional problems of fruit trees. During his stay at Long Ashton he has made, in collaboration with Dr. Wallace, a special study of certain soil problems in connection with the problem of potassium deficiency of fruit trees as it occurs in the larger fruit areas of this country. Mr. Karmarkar has taken up residence with a view to proceeding to the degree of Ph.D. and is engaged in a bio-chemical investigation relating to nitrogen metabolism in fruit trees under the supervision of Dr. Wallace.

Mr. L. G. G. Warne, a student in the Honours School of the Botanical Department of the University, is engaged on a physiological investigation relating to rootstock influence.

During the summer vacation, three students of the University were granted leave to pursue practical work in the Station laboratories, viz., Miss M. Carlton, in the Entomological Department, Mr. G. J. Lewis, in the Chemical Department, and Mr. D. E. Wheeler, in the Chemical and Entomological Departments. The assistance of such students, at the period of the year when there is great pressure of work in the laboratories, is very welcome, and there is no doubt that the experience gained by the students is of great value to them.

It was recorded in last year's Report that, in consequence of the new scheme for the Campden Station, Miss M. L. Adams was to be transferred to Long Ashton, which would serve as the future headquarters for her work on the Domestic Preservation of Fruit and Vegetables. The transfer was effected at the beginning of 1931. A Home Kitchen specially adapted for the work has been provided in the laboratory building. Since no hostel accommodation is available within convenient distance of the Research Station, the summer courses of instruction associated with this work were given by her at the Royal Agricultural College, Cirencester, by arrangement with the College authorities. In spite of some inconvenience in respect of regular supplies of fresh produce required for the courses, owing to the distance from the nearest fruit-growing and market garden centre, the experiment of holding the courses there was a distinct success on the whole and will be repeated during 1932. A small plot of soft fruits has now been planted at the College to serve as a source of supplies on the spot.

Reference was also made in last year's Report to the award of a post-graduate studentship to Dr. J. Bloom for investigations in

insecticides. The funds for this purpose have been provided by the Colston Research Committee of the University. Dr. Bloom began his work in February, 1931, and is engaged on a study of the toxic substances of *Pyrethrum* flowers.

Miss L. D. M. Knight, B.Sc. (Bristol), has held throughout the year the appointment of research assistant in the Chemical Department.

The recent staff increases and the demand for facilities for post-graduate research have led to very congested working conditions in the laboratory building. Efforts to provide more accommodation, therefore, have had to be made. Thanks to a special capital grant forthcoming from the Ministry of Agriculture and Fisheries, supplemented by an equal contribution from the Station, it has been possible to add a new wing to the laboratory building during the year. This will permit of additional room being available for more post-graduate workers in future and will give the existing staff an opportunity of carrying on their work under more satisfactory conditions.

Other changes at the Station have been few. Practically the whole of the land there suitable for field experiments in fruit culture has already been planted up and, with the exception of small plots which come to hand from time to time as the experiments on them are completed, there is little opportunity for new plantings. Provision has been made for permanent quarters for a series of trees relating to the rootstock investigations, and there has also been some additional planting of soft fruits among the tree fruits and elsewhere, where room has been available, in order to secure increased returns from the plantations to counterbalance to some extent loss of income from grant reductions.

The extension of field trials and experiments on growers' fruit farms in various parts of the country, referred to in recent Reports, continues. The results from the earlier established of these are now coming to hand and are affording valuable supplementary evidence, obtained under very varied conditions, to that which is being secured at Long Ashton. To all who, by their co-operation, have made possible this valuable addition to the central trials at the Station, thanks are due.

Although there has been no succession of conferences such as those of 1930 to break into the working time of the staff of the Station, the year under review has not been entirely free from interference by outside calls other than those associated with show exhibits. The Centenary Meeting of the British Association was marked among other respects by the establishment of a Horti-

cultural Sub-Section of the Agricultural Section for the occasion only. This was attended by several members of the staff, some of whom contributed papers.

During September, a special "refresher" course for horticultural officers, lasting for one week, was held at Reading under the auspices of Reading University in conjunction with the Ministry of Agriculture and Fisheries. At this five members of the Station staff contributed papers.

The Deputy Director of the Station, Dr. T. Wallace, who is a member of the Soils Correlation Committee, a body recently appointed by the Ministry of Agriculture and Fisheries and the Board of Agriculture for Scotland for the purpose of correlating soil survey work in Great Britain, was absent from the Station for a period of six weeks in April and May, during which time the Committee made a tour of the various areas in England in which soil survey work is in progress.

The absence of international conferences in this country concerned with subjects in which the Station is interested has been responsible for the falling off of the large influx of visitors from overseas which was a feature of 1930. In spite of that their number has been considerable, including several with special interests in the work of the Station on account of their connection with related researches in their own countries. Among these may be mentioned Mr. W. M. Carne, Senior Plant Pathologist, Division of Plant Industry, Australia; Mr. A. M. Mustapha, Imperial Agronomist, Pusa, India; Prof. A. E. Murneek, University of Missouri, U.S.A.; Prof. R. N. Hodgson, University of California, U.S.A.; Prof. W. V. Filewicz, Sincleka, Poland; Prof. Dufour, Ecole d'Horticulture, Vilvorde, Belgium; and Dr. M. Bahgat, Department of Horticulture, Egypt. There has also been a constant succession of visitors from various parts of this country interested in the Station's general work or some special feature of its ever-expanding programme. Many of them are engaged in some branch of commercial horticulture and their visits have further assisted to strengthen the close link which has been made in recent years between the Station and the horticultural industry.

A feature of the year's visits has been the exceptionally large number paid by organised parties. These are becoming so numerous that it has been found necessary to limit them to bodies having some association with the Station or direct interest in some branch of its work. Among the parties, two may be singled out for particular mention on account of their special character, reference being made to the party of South African farmers touring this

country and that of members of the National Farmers' Union. Reference should also be made to the visit of a party of students of the Institute of Certificated Grocers during their tour of the country, organised by the Ministry of Agriculture and Fisheries. The following is a complete list of the organised parties received during the year :—

Ministry of Agriculture and Fisheries Soils Correlation Committee.
 University of Bristol Botanical Society.
 St. Anne's Park Horticultural Society.
 Nailsworth Branch of the National Farmers' Union.
 Port of Bristol Authority Staff Association.
 Bristol Education Committee's Gardening Classes.
 Herefordshire Branch of the National Farmers' Union.
 Oxfordshire Education Committee Horticultural Party.
 National Fruit and Cider Institute (Open Day for Members).
 Workers' Educational Association.
 Faringdon and District Horticultural Society.
 Clifton College Scientific Society.
 Brislington and District Gardeners' Association.
 East Ward Allotments Association, Oxford.
 Institute of Certificated Grocers' Students.
 South African Farmers.
 Backwell Women's Institute.
 Bristol Branch of the Somerset Bee-Keepers' Association.
 National Farmers' Union Touring Party.
 Kilton Agricultural Institute Old Students' Association.
 St. George and Shirehampton Allotments Associations.
 Agricultural Education Association.
 Bristol Post Office Retired Officers' Association.
 Belgian Scientists from Ecole d'Horticulture de l'Etat, Vilvorde.
 Bristol Co-operative Society's Horticultural Association.
 Bristol University Settlement.
 Fishponds Training College Students.

On the occasion of the Annual Tasting Day on Thursday, May 7th, 1931, the prizes awarded under the Cider Competitions Scheme were distributed and an address given by Mr. H. V. Taylor, Horticultural Commissioner of the Ministry of Agriculture and Fisheries, in the unavoidable absence of Earl de la Warr, Parliamentary Secretary to the Ministry. For many years the attendance at this annual function has been increasing. By 1930 it had reached proportions which rendered adequate organisation difficult. The numbers again were largely exceeded in 1931, when a total of over 2,500 visitors was recorded. Steps may therefore have to be taken in future to limit the party to a manageable size.

The extra-mural work of the Station in the form of lectures, demonstrations, show exhibits and other forms of educational effort continues to expand, and a point has been reached which makes it necessary to place a limit on this side of the Station's activities to prevent undue interference with the normal research and advisory work. Some curtailment of exhibits at shows was imperative in 1931 in view of the very large expenditure of effort and money

incurred through the holding of the Bath and West Show at Long Ashton. At this show, in addition to an unusually extensive exhibit dealing with the various sides of the work of the Department on similar lines to those arranged in previous years, a special exhibit illustrating modern methods of cider making in its practical and scientific aspects was organised. This was probably the most comprehensive exhibit of the kind ever shown in this country. It was included in the building housing the demonstrations of the Ministry of Agriculture illustrating the various National Mark schemes, in view of its special relation to the recently introduced scheme of the National Mark for Cider. It attracted much attention throughout the show and, judging from the nature of enquiries received, served a very useful purpose in demonstrating to farmers and others the conditions required for the production of cider of National Mark standard.

The following list indicates the shows and exhibitions at which educational exhibits were provided during 1931 :—

Bath and West Show, Bristol.
 Devon County Show, Tiverton.
 Three Counties Show, Hereford.
 Wilts County Show, Chippenham.
 Cheltenham Floral Fete, Cheltenham.
 Swindon Allotment Holders' Show, Swindon.
 Shaftesbury and Gillingham Show, Shaftesbury.
 Abergavenny Horse Show, Abergavenny.
 Bedwelty Show, Blackwood.
 Melplash Agricultural Society's Show, Beaminster.
 Evesham Asparagus Growers' Association Show.
 Oxford County Federation Women's Institutes Produce Exhibition.
 Gloucester County Federation Women's Institutes Produce Exhibition.
 Warwickshire Federation Women's Institutes Produce Exhibition.
 Imperial Fruit Show, Manchester.
 Brewers' Exhibition, London.

Reference has been made in detail on previous occasions to various investigations undertaken in collaboration with workers at other institutions. These are being continued and are regarded as of special value, as they afford a means both of widening the scope of the work and of checking results of joint interest to an extent and in a manner not possible otherwise.

With the increased resources resulting from the transfer of the work on Fruit Products from Campden to Long Ashton, it has been possible to extend the work on cider and associated subjects. The establishment of the National Mark Scheme for Cider has involved several investigations on specific questions arising therefrom in conjunction with the Government Chemist. What promises to be an interesting and important line of research on the causes and treatment of the problem known as "caskiness" in casks has been

started in consequence of a special grant made to the station by Messrs. Guinness, Ltd.

It is a pleasant duty again to acknowledge the most useful help rendered by all grades of the assistant staff. Throughout both the technical and administrative staffs there has been a spirit of most loyal co-operation and hearty endeavour to contribute their share to the success of the work of the Station, the attendant difficulties of which have been greatly lightened thereby.

CHEMICAL INVESTIGATIONS RELATING TO POTASSIUM DEFICIENCY OF FRUIT TREES.*

BY T. WALLACE.

In previous investigations at this Station, it has been shown that potassium deficiency in fruit trees is an extremely serious problem in the important fruit areas of this country. As the result of this deficiency, fruit plants such as the apple, gooseberry, black currant and red currant exhibit the condition known as leaf scorch, whilst certain varieties of plums, *e.g.* Purple Pershore, develop a chlorotic appearance in addition to showing the marginal scorching of the foliage.

In former publications, investigations relating to various aspects of the problem have been reported (2 to 7) and the data presented in the papers have included some chemical results illustrating the way in which potassium deficiency has been reflected in the composition of the plants in certain particular cases (3, 5, 6, 7).

Concurrently with the work already described relating to leaf scorch, comprehensive chemical studies were initiated, but the complete results have not been reported hitherto owing to the time required to complete the chemical determinations involved. The more important features of these results are summarised in the present paper.

In this branch of the investigations, it was considered desirable to determine the extent to which potassium deficiency is reflected in the various parts of fruit plants and to see how far observations relating to soil conditions, susceptibility of materials and remedial measures in cases of potassium deficiency could be linked up with chemical features of the plants.

In the course of this work, a very large number of cases of leaf scorch and of the type of chlorosis of plums previously shown to be due to potassium deficiency have been examined, and the chemical results obtained have demonstrated in every case that the scorched and chlorotic conditions of the plants are associated with chemical features typical of acute potassium deficiency.

Data relating to susceptibility of materials to leaf scorch indicate that resistant varieties and rootstocks may possess superior feeding powers for potassium than the more susceptible sorts.

The action of potash manures and of dung in rectifying the deficiency is clearly reflected in the chemical results, and light is thrown on problems concerning the rate of observed responses to ameliorative treatments.

* Reprinted from The Journal of Pomology and Horticultural Science, Vol. IX, No. 2. June, 1931, by kind permission of the Editors.

EXPERIMENTAL.

The Effects of Potassium Deficiency on the various parts of Fruit Plants.

At the commencement of the investigation, it was important to determine the extent to which potassium deficiency is reflected in the potassium content of various parts of fruit plants suffering from acute starvation of the element.

For this purpose, samples consisting of leaves and stem portions of terminal shoots, spur leaves, bark and wood of young shoots and main stems, pulp of fruits and stones of fruits in the case of plums were examined from comparable healthy and potassium deficient plants.

Some typical results which illustrate the salient features revealed by the analyses are presented in Table I (a), (b), (c) and (d).

The data reported in I (a) are from an experiment in which apple trees, variety Stirling Castle on Malling Type I rootstock, were grown in pots in sand, some of the trees receiving a complete nutrient solution and others a nutrient solution from which potassium was omitted (6).

The data presented refer to leaves and stem portions of terminal shoots and four-year-old main stems, and show the effects of the deficiency on the contents of dry matter, ash and potash in the various parts considered.

TABLE I.

Showing the Effect of Potassium Deficiency on the Potassium Content of the various parts of Fruit Trees.

(a)

Chemical Data.	Leaves of Terminal Shoots.	Stems of Terminal Shoots (Winter Stage).*		Main Stems above graft union—4 years old.*	
		Bark. %	Wood. %	Bark. %	Wood. %
<i>Complete Nutrient Series :</i>					
Dry Matter in Fresh Wt. . .	33.92	41.61	48.89	39.71	48.84
Ash in Dry Matter. . .	8.91	6.19	2.28	6.19	1.13
K ₂ O in Ash . . .	45.40	37.83	38.68	35.85	31.12
K ₂ O in Dry Matter . .	4.046	2.342	0.8818	2.219	0.3518
<i>Potassium Omitted Series :</i>					
Dry Matter in Fresh Wt. . .	38.00	46.19	43.96	46.67	53.56
Ash in Dry Matter. . .	7.50	5.57	1.51	5.64	0.70
K ₂ O in Ash . . .	10.58	16.37	18.61	16.77	20.68
K ₂ O in Dry Matter . .	0.7936	0.912	0.2809	0.9458	0.1448
K ₂ O in Dry Matter as % of K ₂ O in Complete Nutrient Series . .	19.62	38.94	31.85	42.63	36.48

* Data on material during third season of experimental treatments.

(b)

Manurial Treatment Annual Spring Dressing from 1912.	Farmyard Manure at 20 tons per acre.				Complete Artificial : Sulph. Amm. 1½ cwt., Super 5 cwt., Sulph. Potash 2½ cwt.				Nitrate of Soda 1½ cwt.				Nitrate of Soda 1½ cwt., from 1912 + Sulph. Potash 2 cwt., from 1923.			
	Terminal Shoots.				Terminal Shoots.				Terminal Shoots.				Terminal Shoots.			
	Leaves. %	Bark. %	Wood. %	Fruit. Pulp. %	Leaves. %	Bark. %	Wood. %	Fruit. Pulp. %	Leaves. %	Bark. %	Wood. %	Fruit. Pulp. %	Leaves. %	Bark. %	Wood. %	Fruit. Pulp. %
Ash in Dry Matter ..	6.81	8.53	2.51	2.10	6.86	9.53	2.64	1.60	5.87	8.91	2.68	0.90	6.66	—	—	1.16
K ₂ O in Ash ..	29.05	14.11	19.04	56.30	22.52	10.06	16.10	56.50	10.73	7.49	11.91	48.40	14.77	—	—	56.2
K ₂ O in Dry Matter ..	1.98	1.20	0.48	1.18	1.54	0.96	0.43	0.90	0.63	0.67	0.32	0.44	0.98	—	—	0.90
as % of K ₂ O in Dry Matter of Complete Arti- ficials Plot ..	128.5	125.0	111.6	131.1	100	100	100	100	40.91	69.79	74.40	48.90	63.63	—	—	100

* Data on Shoots, 1927, on Fruits, 1928.

(c)

Manurial Treatment Annual Spring Dressing from 1921.	Farmyard Manure at 10 tons per acre.				Complete Artificial : Nitrate of Soda at 50 lbs. N., Super at 120 lbs. Total Phos., Sulphate of Potash at 100 lbs. K ₂ O per acre.				Complete Artificial less Potash.			
	Terminal Shoots.				Terminal Shoots.				Terminal Shoots.			
	Leaves %	Stems and Petioles. %	Fruit Pulp. %		Leaves. %	Stems and Petioles. %	Fruit Pulp. %		Leaves. %	Stems and Petioles. %	Pulp of whole Fruits. %	
Dry Matter in Fresh Weight ..	36.20	36.00	10.95		37.20	34.40	10.65		40.25	38.80	11.07	
Ash in Dry Matter ..	8.64	5.65	3.83		7.78	3.64	3.64		8.40	4.73	2.94	
K ₂ O in Ash ..	23.28	22.55	46.30		22.78	24.34	49.00		10.04	13.44	41.55	
K ₂ O in Dry Matter ..	0.20	0.13	0.18		0.18	0.13	0.18		0.084	0.064	0.12	
as % of K ₂ O in Dry Matter of Complete Artificial Plot ..	111.1	100	100		100	100	100		46.7	40.9	66.7	

(d)

Chemical Data.	Healthy Trees.			Potassium Deficient Trees.		
	Spur Leaves. %	Fruit Pulp. %	Stones. %	Spur Leaves. %	Fruit Pulp. %	Stones. %
Ash in Dry Matter ..	11.38	3.25	0.96	6.99	2.40	0.92
K ₂ O in Ash ..	18.51	53.15	32.10	3.78	44.90	32.69
K ₂ O in Dry Matter ..	2.11	1.73	0.31	0.26	1.08	0.30
K ₂ O in Dry Matter as % of K ₂ O in Dry Matter in Healthy Trees ..	100	100	100	12.32	62.43	96.77

The chief points to be noted, which are typical of the large number of cases examined, are that potassium deficiency is reflected in a very definite way in all parts. It results in relatively high dry matter in fresh weight, low ash content and low potash content in both ash and dry matter.

The value at the bottom of each column shows the extent to which the deficiency has lowered the potassium content in each case.

Table I (b) gives data from a field manurial experiment on apple trees, variety Grenadier. The treatments, except in the fourth case, had been given for fifteen consecutive seasons before the samples of leaves and shoots were taken and for one more season before the fruits were examined. It should be noted that the trees on the nitrate of soda plot have been shown to be suffering from potassium deficiency by treating a portion of the plot with sulphate of potash as shown in the fourth case, the potash treatment having produced a marked growth response and resulted in the elimination of leaf scorch in three seasons.

The data also illustrate how farmyard manure has been effective in supplying the amount of potassium necessary to the trees, a result of which has also been obtained at other centres. (See also Table I (c)).

It will be noted from the results that potassium deficiency is clearly marked in the composition of leaves, bark and wood of terminal shoots, and in the pulp of the fruits.

The results reported in Table I (c) are from a manurial experiment on gooseberries at this Station and for which data relating to the action of the various manurial treatments on growth, cropping, leaf scorch, etc., have been previously published (4, 5).

The data given in the present instance are provided for the purpose of showing how closely results with gooseberries resemble those in the case of apples.

Table I (d) gives data in the case of a serious case of potassium deficiency of plum trees, variety Purple Pershore, and illustrates

the manner in which the deficiency is reflected in spur leaves, fruit pulp and in the stones of the fruits.

It will be clear, again, that the deficiency has affected the ash and potash contents of the leaves and fruit pulp as in the previous cases, but it will be noted that the ash and potash contents of the stones have not been appreciably altered.

Soil Relationships.

It has been previously emphasised that potassium deficiency usually occurs in the field in a patchy manner, and in examining such cases, it has been usual to find that soil differences can be recognised between healthy and "scorch" areas.

In addition to comparing the soil features in these cases, it has been usual to examine the composition of comparable portions of the healthy and "scorched" trees. Since potassium deficiency in the field usually leads to the cessation of terminal shoot growth, it has been customary to compare samples of spur leaves in cases of this character, but in some cases samples of fruit pulp have also been analysed.

A very large number of cases have been investigated and, *in every one*, it has been found that the healthy trees were high potassium trees and the scorched trees of low potassium content, thus showing the patchy nature of potassium deficiency in the field.

Some representative cases from the bulk data have been selected to illustrate the point in Table II, and these clearly show the correlation between the soil patches and the potassium contents of the various plants.

Susceptibility of Materials.

Field observations relating to susceptibility of materials to potassium deficiency have been made in connection with classes of fruits, varieties and rootstocks.

Classes of fruits do not lend themselves readily to chemical studies of the character considered herein since opportunities of examining large numbers of varieties of different classes of fruits under comparable conditions do not normally occur, and hence conclusions relating to susceptibility of different classes must be drawn from numerous less critical instances. For this reason, chemical investigations relating to susceptibility have been confined to differences exhibited by varieties and rootstocks.

A case of differential varietal susceptibility in gooseberries is shown in Table III, where the more resistant variety *Whinham's Industry* is compared with the more susceptible variety *Careless*. In this particular case, the *Careless* bushes had failed to make appreciable growth in three years after planting, whereas the *Whinham's*, although exhibiting signs of potassium deficiency, measured on the average approximately 27in. to 30in. in height and spread.

TABLE II.
Showing the Relationships between Healthy and Scorch Areas and the Potassium Content of the Plants on them.

Soil Characters.	Class and Variety of Plant.	Healthy Area.			Scorched Area.		
		K ₂ O in Dry Matter.			K ₂ O in Dry Matter.		
		Leaves. %	Stems. %	Fruit Pulp. %	Leaves. %	Stems. %	Fruit Pulp. %
Keuper Marl Formation—fine sandy loam	Apple—var. Prince	1.94	—	—	0.42	—	—
Glacial Sand—coarse sand	Albert	0.69	—	0.66	0.37	—	0.42
Old Red Sandstone Formation—clay loam	Apple—var. Worcester main	2.26	—	1.39	1.33	—	1.17
Silurian—Old Red Sandstone mixture—close textured silty loam	Plum—var. Purple Pershore	2.41	—	1.41	0.40	—	0.55
Lias Clay with slight coarse sand	Do.	2.11	—	1.75	0.26	—	1.08
Drift admixture—heavy clay	Do.	1.77	—	—	0.41	—	—
River Gravel—light sandy loam	Do.	0.57*	0.61*	—	0.34	0.43	—
Glacial Sand and Gravel—coarse sand and gravel mixture	Gooseberry—var. Careless	2.90	—	—	1.66†	—	—
Lias Clay Formation—heavy clay	Gooseberry—var. Careless						

* This case bushes not healthy but less affected than on "scorched area."

† Severity only very slight.

It will be noted that the Whinham's contain higher percentages of potassium in both the leaves and stem portions than do the Careless bushes, though the percentages of K_2O in the ash of both portions of the Whinham's suggest that the bushes are growing under conditions of too low potash (c.v. values, Table I (c).

TABLE III.

Showing Varietal Effects in Relation to Potassium Deficiency of Gooseberries.

Variety.	Terminal Shoots.					
	Leaves.			Stems.		
	Ash in Dry Matter. %	K_2O in Ash. %	K_2O in Dry Matter. %	Ash in Dry Matter. %	K_2O in Ash. %	K_2O in Dry Matter. %
Whinham's Industry ..	10.37	6.17	0.64	4.73	13.82	0.65
Careless	8.90	3.86	0.34	5.20	8.39	0.43

TABLE IV.

Showing Rootstock Effects in Relation to Potassium Deficiency of Apple Trees.

Variety and Rootstock Type.	Material Analysed.	Ash in Dry Matter. %	K_2O in Ash. %	K_2O in Dry Matter. %
Worcester on Malling Type I.	Green Spur Leaves	9.41	5.29	0.50
Worcester on Malling Type V.	Scorched Spur Leaves	7.25	3.82	0.28

In Table IV the data refer to a case in which the differential effects of two rootstocks are clearly visible, the trees on Type V being obviously more seriously affected than those on Type I. At the time of collecting the samples, the foliage on the Type V trees was mostly severely scorched, whilst scorching was only present to a slight extent on the leaves on the trees on Type I. In taking the samples, leaves of healthy appearance only were collected from the Type I trees and scorched leaves only from those on Type V. This method of sampling would possibly accentuate any differences in composition in the two cases, though the samples were fairly representative of the two sets of foliage.

The values in the table show a definitely higher potassium content in the leaves from the Type I trees, but here again the percentages of K_2O in ash and dry matter suggest that the trees are suffering from severe potassium starvation.

Remedial Measures.

Examples of the effects of applying remedial measures in cases of potassium deficiency by means of potash manures and dung are illustrated in Table I (b) and (c).

The data presented in Table V are from an experiment carried out in a commercial plantation (7), in which a very marked response on gooseberries in a severe case of leaf scorch was observed as the result of two annual dressings of sulphate of potash at 4 cwts. per acre, whereas on red currants, also in a badly scorched condition, these dressings did not produce a visible reaction.

The chemical data show that the potassium content had been increased to a much greater extent in the case of the gooseberries than in that of the red currants. It should be noted that although no appreciable effect had resulted from the potash dressings on the currant bushes, the potassium content had been significantly increased.

TABLE V.

Showing the Difference in Rates of Response to Potash Manuring of Red Currants and Gooseberries.

	Red Currants.				Gooseberries.			
	Potash treated Plot.		Control Plot.		Potash treated Plot.		Control Plot.	
	Leaves. %	Stems. %	Leaves. %	Stems. %	Leaves. %	Stems. %	Leaves. %	Stems. %
Ash in Dry Matter ..	15.58	7.17	13.61	6.71	10.11	5.00	10.72	4.86
K ₂ O in Ash	13.08	10.95	6.42	7.82	23.03	27.24	4.54	6.69
K ₂ O in Dry Matter ..	2.04	0.79	0.87	0.52	2.33	1.36	0.48	0.32
K ₂ O in Dry Matter in Potash treated Material as % of Potash in Control Material ..	243.5	153.8	100	100	485.4	425.0	100	100

An interesting point is illustrated by the data in Table VI, which were obtained from an experiment on plum trees in which the trees on the potash deficient area had shown no appreciable response following three annual dressings of sulphate of potash at a rate of 3 cwts. per acre.

In the fourth season, certain of the trees on the plot were sprayed with a 1 per cent. solution of sulphate of potash at intervals of approximately ten days throughout the growing season in addition to receiving a further spring dressing of sulphate of potash as in previous years.

TABLE VI.

Showing the Effects of 1 per cent. K_2SO_4 Spray on Plum Trees, variety, Purple Pershore, over one season, on composition of Foliage and Fruit.

	Healthy Green Trees.		Potash Deficient Trees—Sprayed + K_2SO_4 manure.		Potash Deficient Trees—Unsprayed + K_2SO_4 manure.	
	Leaves. %	Fruit Pulp. %	Leaves. %	Fruit Pulp. %	Leaves. %	Fruit Pulp. %
Ash in Dry Matter ..	9.97	2.60	6.35	—	4.83	2.20
K_2O in Ash ..	22.69	47.90	20.94	48.10	11.37	33.60
K_2O in Dry Matter ..	2.26	1.25	1.33	—	0.55	0.74

The spraying treatment produced obvious improvement in foliage and fruits, whilst the further manurial dressing did not result in visible response.

The analyses of the leaves and fruit pulp presented in the table show that the spraying treatment was effective in raising the potash content of the portions examined to a level well above that of the trees receiving only the manurial treatment. It is also of interest to note that the data for the “manured only” trees suggest that the manurial treatment has been ineffective as a means of remedying the condition of potassium deficiency.

DISCUSSION.

The results reported in the various sections of this paper show the value of making chemical analyses of various portions of fruit plants in investigating problems of potassium deficiency.

Deficiency of the element is reflected in the leaves, in bark and wood portions of branches and stems and in the pulp of fruits, and by studying the potassium status of these, the condition of the plants can be gauged and the effects of ameliorative treatments followed.

The data relating to soil relationships show clearly the patchy distribution of soil areas conducive to potassium deficiency and illustrate the value of such symptoms as leaf scorch for diagnostic purposes.

It is clear, from the data in Tables III and IV, relating to susceptibility of varieties and rootstocks, that though the differences exhibited are significant, they are not of an order sufficiently large to solve the problems of potassium deficiency solely by the choice of resistant varieties and rootstocks. Even in notable cases of resistance, the potassium content has been much below the point produced by adequate manurial treatment.

Chemical examination of the plant is obviously of great value in experiments in which the results are not easy of interpretation, as in the cases of lack of response to manurial treatment such as are illustrated in Tables V and VI.

In the former case, the chemical results indicate that the two types of plants considered respond at different rates to the treatments given, and in the latter it is apparent that the ordinary method of applying potash manures is not an effective means of obtaining a response in a reasonable period under the prevailing conditions.

Similar cases of lack of response to potash manuring in cases of potassium deficiency of prune trees have been recorded in America (1). It seems probable from the evidence that the lack of response in such cases is due to the applied potash being unable to penetrate to the root systems owing to the absorptive properties of the soils concerned.

SUMMARY.

1. An account is given of chemical investigations which have been carried out in connection with problems relating to potassium deficiency of fruit trees.

2. It is shown that deficiency of potassium produces definite effects on the composition of various portions of the plants.

The deficiency is reflected in the leaves, shoots, main stem and pulp of fruits, but not in the stones of plums.

Percentage dry matter in fresh weight is usually increased, and ash content and potash content in ash and in dry matter are greatly decreased.

3. Soil areas conducive to potassium deficiency occur in patchy fashion in the field. They can be distinguished either by symptoms such as leaf scorch or chlorosis, or by chemical examination of the trees.

4. Observed differences in susceptibility to leaf scorch of varieties and rootstocks are accompanied by differences in potassium content of the plants concerned, but the chemical differences are

too small to suggest that potassium deficiency in the field can be overcome entirely by the use of resistant materials of the nature examined.

5. The action of dung and potash manures in rectifying potassium deficiency is reflected in the composition of the treated plants. The analysis of appropriate portions of plants provides valuable information in attempting to interpret the responses following the application of remedial treatments.

In cases where negligible responses were obtained from potash manures, it is shown that the plants had failed to take in adequate amounts of potassium from the dressings applied.

ACKNOWLEDGMENTS.

Messrs. D. A. Osmond, V. L. S. Charley and J. O. Jones have been responsible for some of the analytical work concerned in these investigations, and the writer gratefully acknowledges their valuable co-operation.

REFERENCES.

- (1) HOAGLAND, D. R. and MARTIN, J. C. Proceedings of the First International Congress of Soil Science, Washington, 1927, p. 390.
- (2) WALLACE, T. "Leaf Scorch on Fruit Trees." *J. of Pom. and Hort. Sci.*, Vol. VI, No. 4, 1928, and Vol. VII, Nos. 1 and 2, 1928.
- (3) WALLACE, T. "Investigations on Chlorosis of Fruit Trees. III. A Chlorosis of Plums due to Potassium Deficiency." *J. of Pom. and Hort. Sci.*, Vol. VII, No. 3, 1928.
- (4) WALLACE, T. "Field Experiment on the Manuring of Gooseberry Bushes." *J. of Pom. and Hort. Sci.*, Vol. VI, No. 3, 1927.
- (5) WALLACE, T. "The Effects of Manurial Treatments on the Chemical Composition of Gooseberry Bushes." *J. of Pom. and Hort. Sci.*, Vol. VII, Nos. 1 and 2, 1928.
- (6) WALLACE, T. "Experiments on the Manuring of Fruit Trees. III. The Effects of Deficiencies of Potassium, Calcium, and Magnesium respectively, on the contents of these elements and of Phosphorous in the Shoot and Trunk regions of Apple Trees." *J. of Pom. and Hort. Sci.*, Vol. VIII, 1930.
- (7) WALLACE, T. "Experiments on the Control of Leaf Scorch on Red Currant and Gooseberry Bushes at Hartlip, near Sittingbourne." *J. of the Kent Farmers' Union*, May 1929.

THE IDENTIFICATION OF RED CURRANT VARIETIES.

BY C. R. THOMPSON.

INTRODUCTION.

There are already several valuable publications dealing with the classification of Red Currants. With the aid of these, it is possible to place varieties into groups according to the species from which they have been derived. From the published data, it is also possible to detect certain varietal differences within the large main groups.

Workers like Sturtevant (1), Janczewski (2) and Bunyard (3), clear much of the ground and leave us in little doubt concerning the history and development of the Red Currant. Bunyard (4) has also worked upon variety identification, and his work forms the starting point for the variety identification tables given in the present paper. Berger (5) has made a comprehensive study of the sub-genus *Ribes*. A summary of the history of Red Currants and a list of varieties with their grouping according to species have been made by Thayer (6). The most recent contribution to the study of Red Currant varieties and their classification is that made by Amos (7). This worker takes a different line of approach and uses fresh characters in his method of identification and in this way is able to include some of the more recent introductions.

It will be realised by this brief survey that considerable attention has already been given to the systematic aspect of Red Currants. There still remains, however, a confusion of nomenclature, and no satisfactory key for variety identification has yet been prepared. An attempt has therefore been made in this paper to present in convenient tabular form the differences between, and similarities among the groups and varieties of Red Currants. This is followed by a short description of each variety. From the tables, it is hoped that anyone with elementary botanical knowledge will be able from a given specimen to identify its group and variety by a simple process of elimination. In fact, the tables are intended to be a key for use in variety identification just as keys are used for flower identification by the systematic botanist.

EXPERIMENTAL.

The primary factors that influence and determine varietal differences are governed by origin. Three species at least dominate the commonly grown English Red Currants, viz. : *Ribes Rubrum*, *R. Vulgare* and *R. Petraeum*. The characters of these three species, which serve as the first basis of separation, are shown by differences in the flower, foliage, and winter wood characters. The following characters are used in the present key :—

Flower Characters.

Distinguishing flower characters are as follows :—

Shape	..	..	..	whether flat, bell shaped or tubular.
Sepals	..	..	..	whether green or flushed with red.
Petals	..	..	..	whether single or bi-lobed.
Receptacles	..	..	..	whether upon and surrounded by a raised pad or fleshy ring.
Flower Truss	..	..	..	either pendent or held stiffly outwards.
Flowers	..	..	..	either lax or stiff pedicels.

Foliage Characters.

Of the foliage characters the following are used with advantage :—

Texture	..	..	..	whether thick or thin.
Hairs on under surface	..	..	..	densely hairy, hairy or slightly hairy.
Leaf Margin serrations	..	..	..	fine, fine and leaf carried to a fine point at its apex, or coarse and rounded at the apex.
Sinus	..	..	..	whether deep, shallow, or absent.
Length/Breadth ratio	..	..	..	whether large or small.
Petiole	..	..	..	whether long or short.

Winter Wood Characters.

The winter wood characters that have been found useful in identification are :—

Epiderm colour	..	..	..	dark grey or brown grey.
Epiderm scaling	..	..	..	whether much or only slight, although this factor varies within varieties according to the season.
Internode length	..	..	..	whether long or short.
Buds	..	..	..	number of buds in apical group ; whether the terminal bud is larger or smaller than those surrounding it ; length of bud.

Other supplementary characters which are extremely valuable are :—

- Season of bud break—whether early or late.
- The colour of the young bud as it develops in spring.
- The colour of the young foliage.

One of the most distinctive group features is the foliage, which may be placed into one of three groups depending upon its sinus character. The sinus may be either deep, shallow or completely absent. With some varieties, on account of the upturned leaf margins, the sinus character may be somewhat obscured. It is

advisable in such cases to press the leaves against some flat surface in order to observe this feature. In some cases, pronounced marginal differences in the foliage render a sinus comparison unnecessary.

It may be noted that variations in the sinus depth also contribute to variations in leaf shape. In the first place, for example, where the sinus is very deep, the midrib is in consequence comparatively short, whereas when the sinus is shallow the midrib is comparatively long. Furthermore, in the case of a deep sinus, the side lobes of the leaves are directed sideways and outwards from the midrib, whereas in the shallow sinus leaves, the side lobes are directed forwards towards the leaf tip and make an acute angle with the midrib. Where the sinus is absent or almost absent, the side lobes appear to be absent also. This effect of the sinus character upon the angle which the side lobes make with the midrib is intimately connected with leaf shape. The deep-sinus leaves appear pentacuspitate and the shallow-sinus leaves appear tricuspidate.

VARIETY IDENTIFICATION.

Given an unknown specimen of red currant, the following key may serve as a means of group identification. From this, one may proceed to the table of varieties belonging to the group concerned. Following these tables is the list of varieties with a short description of each. It must be mentioned here that, although all varieties have not up to the present been collected, these tables serve as a guide for the identification of all varieties met with in commerce.

It is possible to distinguish certain *group* features at any time of the year with a large degree of certainty, but it is to be understood that the best period for observation is from the flowering period until autumn characters begin to show themselves. On the other hand, it is possible only within this latter period to distinguish the *varieties* themselves with certainty. On this account, the subsequent tables dealing with the varieties confine themselves to leaf and shoot characters.

Table I embraces the whole range of group differences occurring over a year. The column on the extreme left of the table is divided into three sections which indicate characters to look for according to the period at which observation is made. The four columns to the right of this one, one for each group, contain descriptions which denote the nature of these characters for varieties within each group.

TABLE I.
Showing the distinctive group characters of the main Red Currant Groups.

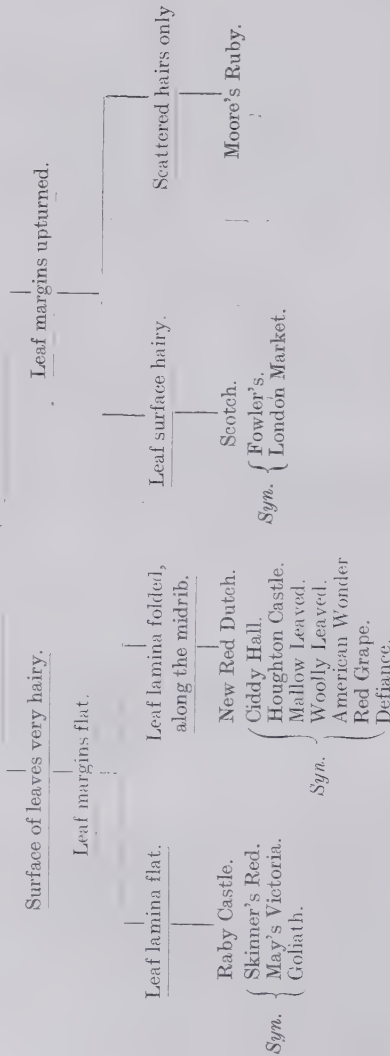
<i>Ribes Rubrum.</i> (Raby Group).		<i>Ribes Vulgare.</i> (Dutch Group).	<i>R. Vulgare Macrocarpa.</i> (Versailles Group).	<i>Ribes Petraeum.</i> (Gondouin Group).
Spring Characters. <i>Flowers.</i>				
Shape ..	..	Bell shaped.	Flat.	Tubular.
Sepals ..	..	Generally red tinted.	Green.	Claret Red.
Petals ..	..	Bi-lobed.	Single lobed.	Single lobed and large.
Receptacle ..	..	No raised ring.	Raised ring.	No raised ring.
Flower Truss ..	..	Held stiffly outwards on stiff pedicels.	Held pendent on lax pedicels.	Held stiffly outwards on stiff pedicels.
Summer Characters. <i>Foliage.</i>				
Texture ..	..	Thin.	Thick.	Thick.
Hairiness of under surface ..	..	Densely hairy.	Generally hairy.	Slight.
Margin ..	..	Finely serrated prolonged to spines.	Fine.	Medium to fine.
Sinus ..	..	Shallow.	Deep.	Absent.
Lamina—Dimensional ratio		6.3 — .71	6.0 — .69	9.6 — .94
Petiole length ..	..	8.8 — 1.0	8.7 — 1.0	10.2 — 1.0
		Medium : average = 3.4 cms.	Short : average = 2.5 cms.	Long : average = 4.5 cms.
Winter & Spring Characters.				
Colour of Wood ..	..	Brownish grey, some scaling.	Dark grey, much scaling.	Dull grey, much scaling.
Internodes ..	..	Short.	Rather short.	Rather short.
Apical buds ..	..	4-5 one central larger bud.	3-5 one central larger bud.	3-4 one central smaller.
Lateral bud size ..	..	Medium length.	Medium length.	Very large.
Season of bud break ..	..	Generally late.	Generally late.	—
Young bud ..	..	—	—	—
Young foliage ..	..	—	Crimsoning at tip.	Much redness and browning.

I.—*RIBES RUBRUM* (RABY) GROUP.

The varieties of this group can easily be distinguished by their leaf characters, classified in a convenient form in the following table :—

TABLE II.

Showing the system of identification of the varieties within the
Ribes Rubrum Group (*Raby* Group).



Of the varieties within this group, the two varieties Raby Castle and New Red Dutch are easily recognised because their very hairy leaf surfaces give the foliage a distinctly whitish appearance. On this account, although "*rubrum*" in origin, the texture of the leaves of these two varieties cannot be described as thin, but it has a velvet-like feel. Both varieties have strong tendencies to develop secondary buds.

Raby Castle. (Synonyms : *Skinner's Red*, *May's Victoria* and *Goliath*.) This variety is of vigorous growth, with bush very erect. The leaf serration is somewhat coarse and more rounded than that of New Red Dutch. It is a variety that has been extensively grown, but of late years has, in general, been cropping poorly, due probably to a mite disease akin to Big Bud of black currants. This behaviour has also been noticed and given closer study by Massee (8).

New Red Dutch. This variety has been found growing under the following names :—*Ciddy Hull*, *Houghton Castle*, *Mallow Leaved*, *Woolly Leaved*, *American Wonder*, *Red Grape* and *Defiance*. The bush is of spreading habit, of medium vigour, and a very prolific cropper. The berries are small and of mid-season.

There has been much confusion of New Red Dutch with Raby Castle, but the spreading habit and the somewhat folded leaf of New Red Dutch should be enough to distinguish it from Raby Castle with its flat leaves and erect bush habit. Again there is the marked difference in fruiting capacity in favour of New Red Dutch.

London Market. This has also been received under the names of *Scotch* and *Fowler's*. The growth of this variety is very vigorous and the bush erect in habit. It can be readily distinguished by the mouse-coloured to otter-brown epiderm (9) and by the cup-shaped leaf which is pale green in colour with a distinct whitish rim. There is a strong tendency to develop secondary buds and the internodes are extremely short. The berries are large, bright red in colour and the variety crops well when lightly pruned.

Moore's Ruby. This is a very vigorous grower, and has leaves of a dark glaucous green colour. The berries are of average quality and late in season. The dark leaves of this variety clearly distinguish it from *London Market*. The lateral buds are often abortive.

II.—*RIBES VULGARE* (DUTCH) GROUP.

It will be seen that one of the more recently introduced varieties Laxton's Perfection is included in this group. Similar characters are employed in the following Table III as are used in the *Ribes Rubrum* Table (Table II):—

TABLE III.

Showing the system of identification of the varieties within the
Ribes Vulgare Group (*Dutch Group*).

Leaf margin upturned.		Under surface few hairs.	
Upper leaf surface smooth.	Upper surface hairy.	Leaf margin flat.	Leaf margin down-turned.
	Under surface dense hairs.		
Under surface hairy.	Under surface few hairs.	Leaf margin flat.	Laxton's Perfection.
Dutch. (Utrecht. Syn. Kirsche.	Fertility. Skinner's Early.	Allongue Grappe. (Syn. Wilson's Long-bunch).	
(Knight's Sweet. Caucasische. Hollande Rouge.	Champagne. (Syn. Red Champagne).		

Dutch. This variety has been received under the names of *Utrecht*, *Kirsche*, *Knight's Sweet*, *Caucasiche*. The variety grows vigorously and the bushes are erect in habit. Its foliage is rather pale green in colour with a distinct yellowing round the margins. The fruit is of medium size and of mid-season. This is one of the most widely grown varieties of the group.

Hollande Rouge. This variety is very similar to Dutch except that the bushes are much weaker and the twigs more slender. It has not yielded so well as Dutch at Long Ashton.

Skinner's Early. This is the earliest variety in the collection at Long Ashton. Of the group it is probably the largest leaved variety, and grows vigorously. Like Dutch the bushes are erect in habit. A noticeable feature of this variety is the number of secondary buds on the maiden wood.

Fertility. Of all the varieties in the collection at Long Ashton, this is the first to break into leaf. The general appearance of the bushes during full leaf is markedly like Skinner's Early, but the leaves are smaller and rather darker green in colour. Again, the fruit ripens later than that of Skinner's Early.

Red Champagne. (Synonym: *Champagne*.) The season of this variety appears to be late both in bud break and the season of fruit ripening. The mature foliage is similar to Dutch, but cannot be confused with it on account of the rugose, yellow shoots of the Red Champagne. Marked features of the maiden wood are the irregular internodes and the abortive nature of the buds.

Wilson's Long Bunch. (Synonym: *Alongue Grappe*.) The growth of this variety is rather weak and the bushes semi-erect in habit. The leaves are flat and have distinct yellow margins. These two features serve to distinguish this variety. The yellow margin of the leaves of Wilson's Long Bunch is wider than that of Scotch or Dutch and gives the appearance of nitrogen deficiency. Another noticeable feature of this variety is the pale colour of the berries, which are medium in size and late in season.

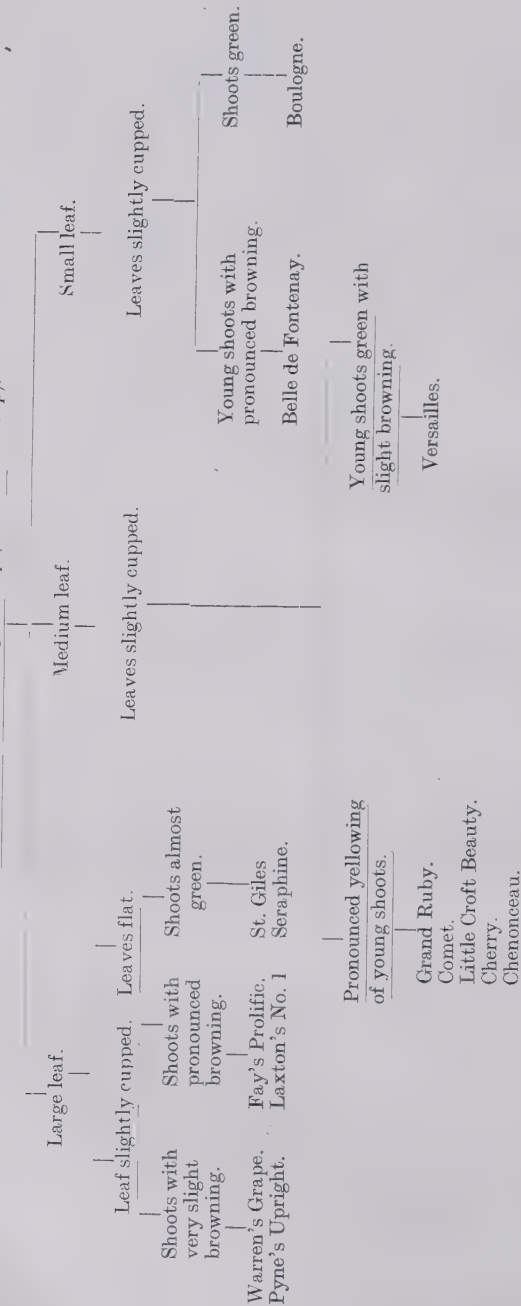
Laxton's Perfection. This variety is of medium vigour and readily distinguished by the down-turned leaf margins. The raceme is very long and its berries are very large. Of the varieties in the Long Ashton collection, it produces the largest berry. It is liable to over-crop and suffer from broken branches. There is a strong tendency for the buds to be abortive, which results in irregular internodes. Many growers experience difficulty in establishing bushes on account of the abortion of both lateral and terminal buds, but where this difficulty does not occur it is by far the most prolific variety.

III.—*RIBES VULGARE MACROCARPA* (*VERSAILLES*) GROUP.

In Table IV a slightly different method of procedure has been adopted than in Tables II and III. Leaf hairiness has not been taken into consideration, but in addition to leaf shape such characters as leaf size and shoot colour are used.

TABLE IV.

Showing the system of identification of the varieties within
Ribes Vulgare Macrocarpa Group (Versailles Group).



The varieties of this group are somewhat mixed and are difficult to distinguish. Furthermore they are found under many names. At the present stage, with such confusion of nomenclature and mixture of varieties, an attempt has only been made to divide the group into the large, medium and small leaved types, sub-dividing these into the flat and cupped types. This division is used along with young shoot characters, which may be green, green with browning or a pale yellow green.

There is a strong tendency in this group to produce abortive buds. Particularly is this so with Pyne's Upright Strain and Seraphine. In some cases the *terminal* buds become abortive and the shoots are said by the growers to go "blind." On this account many varieties in this group often fail to make good bushes. The average width of the leaves of the large leaved group is 9 cms. and over, the medium group 7.7 to 8.9 cms., and that of the two varieties assigned to the small leaved group is less than 7.3 cms. All leaf measurements were taken from mature leaves on bushes about seven years old.

Belle de Fontenay. This variety is of medium vigour and upright in habit with very small leaves, being the smallest leaved variety in the group. The young shoots have a pronounced browning. It is a variety of little value when compared with others in the group.

Fay's Prolific. The bush is of moderate growth, upright in habit, with shoots showing a pronounced browning. The berries are large and early in season. It has been a most popular variety.

Laxton's No. 1. This is of vigorous habit, upright, and somewhat similar to Fay's Prolific, but the fruit trusses are much longer. It is early in season and a prolific cropper, with very large berries. The variety has a tendency to develop a number of secondary buds. It is one of the more recent additions to this group and surpasses by far the merits of many of the older ones.

Cherry, Chenonceau, Comet, Grand Ruby and Little Croft Beauty. These varieties are all somewhat similar, and closely allied to Fay's Prolific. The leaves are smaller and the young shoots pale, yellow green. Chenonceau is outstanding in that it has a very irregular phylotaxis and a very irregular internode length.

Pyne's Upright Strain, Warren's Grape. These again are somewhat similar to Fay's Prolific but show little or no shoot browning. The buds of both are very abortive, particularly so in Warren's Grape, which for this reason has failed to make a bush here. It has not yet been decided whether these two are distinct varieties.

Seraphine, St. Giles. These varieties have large flat leaves, and are by far the largest leaved varieties of the Versailles group. The buds are abortive and both varieties have almost invariably failed to make bushes here on this account. Seraphine has very irregular internodes. It has not yet been decided whether these are distinct varieties. They are still under further observation.

Versailles. The variety is very similar to Fay's Prolific, but the mature leaves are smaller and the shoot browning is not so pronounced. The berries are later in season than those of Fay's Prolific.

Boulogne. The bushes of this variety have a very weak appearance on account of the slender type of twig and shoot it produces. A noticeable feature is the tendency to develop secondary buds. The leaves are small and show much yellowing, which gives them a mottled appearance.

(It is realized that the notes upon certain of the varieties in the above group are rather meagre. It is, however, difficult to give more details at this stage. Most of the varieties are still under close observation, and it is hoped that further distinguishing characters may be forthcoming in due course.)

IV.—GONDOUIN GROUP.

The varieties in this group are derived from *Ribes Petraeum*. It has very few members to its credit in the commercial cultivation of red currants. Only one of these varieties is included in the Long Ashton collection at the present time. It can be seen from Table I that this variety, Rivers' Late Red, has features which distinguish it at once from all other varieties. There is no leaf sinus, the flowers are tubular and claret red, and there is much redness and browning in the young foliage and shoots. The above features are characteristic of the group.

Rivers' Late Red. The habit of the bush is somewhat straggling. This feature, together with the large buds and the excessive scaling of epiderm in the young wood, make the variety readily distinguishable during winter. The mature leaf is dark green and similar in colour and contour to the Horse Chestnut leaf. The fruit is of claret red colour and late in season.

BIBLIOGRAPHY.

- (1) STURTEVANT, E. LEWIS. "History of the Currant." *Western New York Horticultural Society Report*, 1887.
- (2) JANCZEWSKI, E. DE. "Monographie des Groseilliers." *Memoires de la Societe Physique et d'Histoire Naturelle de Geneve*, Vol. 35, 1907.

- (3) BUNYARD, EDWARD A. "The History and Development of the Red Currant." *Journal of the Royal Horticultural Society*, 1916-17, Vol. 42.
- (4) BUNYARD, EDWARD A. *Journal of Pomology*, Vol. 2, 1920-21. "A Revision of Red Currants."
- (5) BERGER, ALWIN. "A Taxonomic Review of Currants and Gooseberries." *New York State Agricultural Experiment Station, Geneva, N. Y. Bulletin No. 109*, 1924.
- (6) THAYER, PAUL. "The Red and White Currants, their History, Varieties and Classification." *Ohio Agricultural Experiment Station Bulletin No. 371*, 1923.
- (7) AMOS, J. "Red Currant Varieties." *Annual Report East Malling Research Station*, January-December, 1928.
- (8) MASSEE, A. M. "The Life History of the Black Currant Gall Mite, *Eriophyes ribis* (Westw.), Nal." *Bulletin of Entomological Research*, Vol. 18, pt. 3, February, 1928.
- (9) REPETOIRE DE COULEURS. Publié par la Société Française des Chrysanthemistes et Rene Oberthür avec la collaboration principale de Henri Dauthenay.

STUDIES ON MATURITY OF FRUIT.

I.—INTRODUCTORY.

II.—PRELIMINARY OBSERVATIONS ON THE RATE OF SOFTENING OF APPLES.

BY J. C. HINTON.

I.—INTRODUCTORY.

The importance of maturity as a factor in fruit quality is slowly becoming more and more evident and, in this introductory section, a brief summary of the facts which are already known is set out and the probable significance of these suggested. It is mainly from the study of apples and pears that our knowledge has been obtained, and only data relating to these will be considered here.

The facts may be considered conveniently from two viewpoints :—

- (a) Those which concern the fruit growing industry, embracing the effect of maturity on commercial quality and in particular storage quality.
- (b) Those concerning the fundamental processes of the metabolism of the fruit.

Maturity and Storage Quality.

One of the earliest observations, by Powell and Fulton of the United States Department of Agriculture in 1903, (33) showed that apple scald occurred mainly in immature fruit. This has been verified by Ramsey, McKay, and others in 1917, (34) by Brooks, Cooley and Fisher in 1919, (5) in both cases from the same department, and by Plagge and Maney of Iowa in 1924 (30 and 31), control of the disorder being obtained by delaying the picking date.

The most usual forms of storage breakdown of Jonathan, Newtown, Delicious and Grimes have been controlled by earlier picking by Palmer, at Summerland (28, 29), Plagge and Maney in Iowa (30). Coe, Wilson and Abell in Utah (10), Hartman in Oregon (13), and by workers at the Hood River Research Station, Oregon (17).

The control of Jonathan breakdown was so effective that Palmer entirely eliminated it in practice in the Penticton district by a careful regulation of the picking date.

Smith of the Department of Scientific and Industrial Research (35) pointed out that bitter-pit of apples could be controlled by regulating the picking date. Carne of Western Australia (8 and 9), has extended the observations, and has obtained control on a commercial scale by picking the fruit at a sufficiently late date. As an index he used the extent to which starch had disappeared from the flesh of the apple, as indicated by the application of an iodine solution to the cut surface. Starch which is present in immature apples is hydrolysed and disappears as the fruits become more mature. Apples picked when the starch has reached a certain stage in its disappearance do not develop bitter-pit to an appreciable extent.

Core-breakdown of pears was shown by Hartman in Oregon (14) to be controlled if the fruit was not left on the tree too long, and Harley, as reported in the Journal of Agricultural Research (12), has verified this, and also finds the acetaldehyde content, which is thought to be connected with breakdown, similarly influenced by the date of picking. Magness, Diehl and Allen (23) note that control is obtained mostly on fruit from warmer districts by this regulation of picking.

The general deterioration in quality of pears, from the Rogue River Valley, led to the development by Murneek in Oregon in 1921 (26) of the pressure test as an indication of maturity in order that growers might have some definite information as to the best time for picking. This test is based on the fact that fruits soften in texture as they approach maturity, the pressure needed to drive a metal plunger of standard size a definite distance into the flesh of the fruit being recorded in pounds. More recently, the reliability of the test has been confirmed and the use extended by Hartman, Reimer and Norris in Oregon (15 and 16), and by investigators at the Hood River Research Station, Oregon (17). Magness, Diehl and Allen of the United States Department of Agriculture (23) also find the pressure test reliable, but it is noted by all that the optimum picking hardness for fruit from one district or set of conditions may not necessarily be the best picking hardness for fruit from other conditions or districts. This means that it is not the *actual* hardness value itself which matters but the stage of maturity empirically indicated by the hardness test. The pressure test is now in general use in the United States by pear growers to determine the appropriate time for picking to obtain the desired quality features.

Hardness is not found to be a reliable index in the case of apples, the most useful one in the opinion of all workers being the change in the ground colour from green to yellow. In the experience of Palmer, each variety of apple needs to be examined, and its own particular standards worked out.

There are many other publications which are not mentioned above setting forth similar observations, and giving complete verification to the points which have been enumerated. It is therefore definitely established that the maturity of fruit at picking time has a marked influence on the quality and general behaviour of it during storage.

Metabolic Processes in Relation to Maturity.

A clearer understanding of maturity problems can only be obtained through a knowledge of the fundamental processes which are involved in the metabolism of fruits throughout their life histories. Such knowledge as is available suggests that there is no marked and readily recognised condition of the fruit which can be defined as the mature condition. The difficulty which Palmer and others have encountered in obtaining an easily used index of maturity would suggest this. Of the indices examined, hardness, seed colour, ground colour, ease of picking, etc., not one is a strict index of maturity. Some cannot be used at all, but even those that are of use need to have their relation to maturity worked out empirically for each different set of conditions. Maturity is not a definite term applicable to a marked and readily recognised condition of the fruit.

From the commencement of its life at the setting of the flower, during the stages of growth in size and accumulation of reserve materials, and through the period of storage when those materials are used up in respiration to the final death and decay of the fruit is a continuous sequence of processes so far as the fruit is concerned. In this strict physiological sense, maturity is not reached until the final stage of the above processes is complete, and the stages of maturity which we define are thus purely arbitrary ones, chosen to meet practical requirements or for convenience of study. A fruit regarded as mature to pick may be immature from the eating viewpoint, and each of these stages may represent no definite physiological stage in the history of the fruit itself. It is this lack of physiological definition which makes standards of maturity so difficult to obtain, the population of each environment needing to be studied on its own merits.

What is really established is that the stage in the development of a fruit at which it is picked markedly influences its behaviour

after picking. The knowledge of what this involves fundamentally is only slowly being elucidated.

The Metabolism of the Growing Fruit.

Lindet in 1894 (20), Bigelow, Gore and Howard in 1905 (4), Magness and Burroughs in 1922 (22), Magness and Diehl in 1924 (25), Neller and Overley in 1926 (27), Plagge, Maney and Gerhardt in 1926 (32), St. John and Morris in 1929 (36) and Archbold in 1928 and 1930 (2 and 3), in work carried out in varying detail on the development of apples on the tree, came to the same general conclusions regarding the relationships between maturity and changes in certain major constituents of the fruits.

The production of acid decreases and may even cease early in the development of the fruit, so that the proportion of it in the total weight of the fruit does decrease steadily.

On the other hand the proportion of soluble carbohydrates in the total weight increases steadily during the growing period, sucrose increasing more rapidly than the hexoses do in the later part of the season.

Insoluble carbohydrates, starch, cellulose and acid hydrolysable materials increase for some time and then decrease.

Dry matter increases steadily in proportion in the total weight during the later part of the growing season.

Magness, in 1920 (21) in comparable studies with pears, came to similar general conclusions, except that the acid in fruits from some districts tended to increase during the development on the tree.

Archbold, in 1930 (3) in a more detailed study, shows that during the later period of growth, the rate of production of starch and other alcohol insoluble materials falls off to zero after which these substances decrease in amount in the fruits. During this later period the rate of increase of total solid matter also declines, but the increase in sucrose continues. Since there is a decrease in the rate at which total solid matter is being accumulated, it is probable that the continued increase of sucrose at this later period of growth is only maintained by the hydrolysis of the starch and other hydrolysable materials which are being lost. The rate of increase of sucrose is not maintained after the starch has disappeared, but begins then to decline in the same way that the rate of increase of total solids is doing. During this second period, marked by the decline in increase of sucrose and of total solids, the increase in hexoses is maintained, and again it is argued by the hydrolysis of materials already present such as sucrose, and other polysaccharides.

During this same later period, Plagge, Maney and Gerhardt in 1926 (32), and Haller in 1929 (11), found a decrease in acid hydrolysable materials, especially insoluble pectin.

The period during which these changes are taking place extends over the normal picking time, fruit usually being picked during the period when starch is being lost. It must be emphasised that it is the *rate* of increase which is declining; there still is an increase of solid matter and sucrose so long as the fruit remains on the tree.

The important fact which emerges from this evidence is that, during this later period of ripening on the tree, there is a loss of hydrolysable materials.

The Metabolism of the Stored Fruit.

All the above-mentioned workers are similarly in general agreement about the course of events during storage. There is a loss of solid matter, sucrose, acid, pectin and other acid hydrolysable materials, while hexoses increase to a certain point. If starch is present when the fruits are picked, there may be an increase in sucrose during the early storage period, starch being hydrolysed at this same time (3 and 4). The material which is lost during storage is ultimately respired, but again the fact which is stressed is that complex bodies are hydrolysed and lost, a process which commenced while the fruit was still on the tree.

Thus the metabolic history of the fruit can be generalised as a fairly rapid attainment of a high rate of production of the fruit material, which rate decreases as development proceeds, but has not completely ceased at the time when the fruit normally leaves the tree. At the same time, the processes of breaking down and using any available materials, in addition to becoming apparently more important due to the slow cessation of the opposite building up processes, are probably slowly increasing in actual rate. This actual increase is suggested by Archbold's data (3) by the commencement of softening, which Appleman and Conrad in 1926 (1) and Haller in 1929 (11) show to be closely correlated with the loss of insoluble pectin in particular and pectin bodies in general, and by the increase in rate of respiration taking place during the later growing periods found by Burroughs in 1922 (6 and 7).

It is thus evident that during the later period of growth, the building up and breaking down processes are going on at the same time; there is a gradual change from a state in which the former is the more important to a state in which the latter is predominant, and the change is apparently continuous. The existence of a true physiological state of maturity cannot be postulated under

such conditions. To do so, it would be necessary to find that there was a period during which change was undetectable, such as is seen in the resting period of seeds.

The Effect of Picking on Subsequent Metabolic Changes.

As the ripening fruit nears the normal picking date, it would seem that the breaking down processes are gradually becoming more and more active and important, although at the same time the building up processes are still raising the absolute amount of synthesised materials to a higher level, from which point the final storage life will start. Hence by regulating the time of picking, two factors which are concerned in the subsequent history of the fruit are influenced :—

(a) The level of synthesised materials.

(b) The rate which the breaking down processes have attained.

The effect of such influence is seen in the control that time of picking can have on the various storage disorders and on other aspects of quality, and in the few observations which are available on the effect on certain of the fundamental processes which take place after picking.

Softening of the flesh, which commences while the fruit is on the tree, continues after picking, and Magness and Burroughs (22), Magness, Haller and others (24), and Neller and Overley (27), find that the rate of softening in storage is quicker in later pickings of fruit. This softening, it will be remembered, is related to the loss of pectins.

Magness (21) finds that pears which were picked at a later date ripened more quickly in storage than the earlier picked ones.

Magness and Burroughs (22) also find that the rate of respiration increases more rapidly during storage in the later picked fruit.

In connection with both of these phenomena, the rate of respiration and the rate of softening in store, there is an increase in rate with the passing of time, up to a maximum after which there is a decrease, unless low temperature storage is used. In each case, there is a lag between the time of picking and the time at which the increase in rate becomes noticeable. In later pickings, this initial lag is of shorter duration and tends to disappear. It seems as if what might be termed the normal storage metabolism is more readily attained in the later pickings and proceeds at a quicker rate. Storage metabolism appears to consist entirely of hydrolysing processes, certainly there is no further increase in food materials. It is suggested that there may be a connection between the sudden stoppage in the supply of food materials which picking

causes and the subsequent increase in the rate of storage metabolism ; and further there may be a connection between the *gradual* decrease in the supply of food materials, and the more ready attainment of the storage metabolism which takes place during the later critical period of growth on the tree. Further reference is made to this suggestion later.

Archbold (3) finds that the rate at which sucrose is lost in store is greater in the later pickings of apples than in the earlier ones. This higher rate of loss is not, however, maintained and the initial rate begins to decline sooner in the later pickings than in the earlier ones, so that at the points where the rates begin to change, approximately the same amounts of sucrose have been lost from the earlier, and the later pickings. The fruits from the later pickings start off with a higher concentration of sucrose, so that in these fruits the concentration is still high when the rate of loss begins to decline.

Hartman (13) reports that the rate of loss of total weight, including water, is less the later the fruit is picked. Archbold, and Bigelow, Gore and Howard, find similarly that the rate of loss of total solids is less in later pickings of apples. It seems difficult to understand how the loss of solid matter should be less, while the rate of respiration is higher as found by Burroughs. All such observations, however, need to be extended and made on the same sample of fruit before it will be possible to relate them to each other.

The Possible Influence of Various Orchard Factors on Maturity.

Not only is the time of picking of undoubted importance, but other things which may influence the factors involved in maturity of the fruit whilst on the tree require consideration. The removal of the fruit from the tree completely stops any further supply of food materials, and may be the actual cause of the increase, which takes place after picking, in the rate at which the hydrolysis and breaking down processes proceed.

Burroughs in the case of Wagener apples (6) and Lewis, Murneek and Cate (19), in the case of pears state as a matter of observation that continued contact with the tree retards the ripening processes as compared with similar fruits removed from the tree. This indeed must be so if the rate of softening and other hydrolysing processes increases after removal from the tree.

It was suggested previously that there may be a connection between the fact that during the later tree-ripening period of fruits there is a decrease in the rate of food supply and an increase in the ease with which storage metabolism starts. It may be that a continuation in the supply of food has a depressing influence on the

hydrolysing processes, which may thus receive some measure of control from the rate at which food is supplied. Thus any factor which affects the food supply, particularly during the later period of ripening on the tree, may affect the maturity and ripening processes. Hartman in fact does state that pears from heavily loaded trees, the food supply of which is thus probably restricted, ripen earlier than ones from lightly loaded trees (13). Other factors such as climate and orchard treatment may influence the fruit in a similar way.

Tiller of the Cawthron Institute (37) has reported that breakdown of Jonathan and of Sturmer is influenced by orchard manuring. Manuring influences vegetative growth and leaf surface, both of which are concerned with the general balance of food materials available in the tree and for the fruit. Palmer has already shown that time of picking controls this type of breakdown, and it is suggested that the effects obtained both from time of picking and manuring are produced, in part at any rate, by the inter-relation of food supply and maturity.

Kikuchi (18), from a study of the form of pears under various experimental manurial treatments, states that the chief effect of the manurial treatment on the fruits is to influence their maturity.

From a consideration of the facts known and set out above, it seems obvious that maturity exercises a very important influence as a factor in determining the various aspects of quality of fruit, though it is still very far from possible to express it in terms of the fundamental processes involved.

The work which is being described in the studies reported in the present series is hoped in part to contribute towards a better understanding of various problems relating to maturity.

The following subjects concerning various aspects of maturity problems are at present under investigation, and the results of the studies will be reported in the near future.

1. The intake of minerals into fruits of gooseberry.
2. Aspects of the relationship of starch and sugars in apples grown under various conditions.
3. The maturity of apples in relation to some cultural treatments.

II.—PRELIMINARY OBSERVATIONS ON THE RATE OF SOFTENING OF APPLES.

The effect of orchard conditions on fruit quality being under investigation at the present time at Long Ashton, the influence

of certain of these on some processes involved in maturity has been examined. The rate of softening and the sugar relations in some particular cases have been investigated, and though the results are only of a preliminary nature, they are presented here, since they have a definite bearing on the foregoing discussion of maturity. The results from the chemical investigations will be presented in detail in a later paper.

The pressure test, which is used extensively in America for determining the picking maturity of pears is based on the well-known fact that fruits soften as they become ripe. The rate of softening may therefore, under favourable conditions, be an index of the rate of ripening, and a given hardness value may represent a particular stage in the ripening process. The actual hardness value, however, is determined by several factors, some of which are external, and are not related to the ripening processes. The usefulness of the hardness value as an index of ripeness is therefore limited, and the relationship between hardness and ripeness needs to be determined empirically for each set of conditions. Some of these disturbing influences have been recognised by Hartman (13) and Magness, Haller and others (24). Loss of water, giving a less turgid fruit, causes the hardness to be greater; larger fruits are less hard than comparable smaller ones; much reddening of the fruit, which is accompanied by a thickening of the walls in the outer layers of flesh, makes it harder; and fruits at higher temperatures may be softer than those at lower; all of these factors are independent of the stage of maturity.

During the course of the work which has been done at Long Ashton with the pressure test, it has been confirmed that large fruits are softer and red fruits harder than the average of the sample.

Hartman further states that the removal of part of a crop interferes with, almost stopping, the softening of the remainder, though the other maturing processes are not so much affected.

In spite of these limitations, the pressure test can yield useful information, if used with caution, and disturbing influences are recognised and eliminated.

Haller (11) finds that the rate of softening is closely correlated with the loss of pectin bodies, especially insoluble pectin, and Magness and Diehl (25), and Magness, Haller and others (24) show that it is decreased, together with the other features of the maturing process, by gas storage, low temperature storage, and coating of the fruit with oil, whilst being closely correlated with the rate of respiration. It can thus be a useful index of certain of the fundamental processes.

The pressure-tester employed in the present experiments was made according to the specification of Murneek (26). The plunger was $\frac{1}{2}$ -inch in diameter and penetrated 3 16ths inch into the flesh. The apples used were the variety Newton Wonder, and pickings at different dates were made from trees under the following differential treatments :—

1. Growing under clean cultivation.
2. Growing under grass.
3. Growing under clean cultivation, but older trees than 1 and 2 and in a different part of the orchard.
4. As 3, but bark-ringed.

The ringing was carried out by the two overlapping half-ring method in the spring of the same year that the fruit was gathered, *i.e.* 1930.

The figures relating to hardness represent the average pressure in pounds registered by the tester of 5 or 6 tests made on each of 6 to 8 representative peeled fruits. Complete curves were prepared from the data obtained, and the figures presented and compared in Table I were extracted from the curves.

Each picking was made from a different tree in order to avoid complication from thinning though it involved the complication of variation between trees.

TABLE I.
Variety—*Newton Wonder*.

	<i>Pick 1.</i> September 10, 1930.		<i>Pick 2.</i> September 26, 1930.		<i>Pick 3.</i> October 21, 1930.		<i>Pick 4.</i> November 4, 1930.	
	A	B	A	B	A	B	A	B
Grass ..	22.0	2.0	22.0	6.0	19.0	6.0	—	—
Cultivated ..	22.0	3.0	22.0	6.0	18.0	5.5	—	—
Ringed ..	22.5	3.0	20.0	2.5	17.5	4.0	18.0	8.0
Not Ringed ..	23.0	3.5	22.0	4.0	20.0	4.5	17.0	8.0

A = original hardness value on picking.

B = loss in hardness value during 36 days in store.

These figures are in agreement with the observations already quoted :—

1. Fruits from orchards which differ only slightly, behave

differently ; there has been no softening in the fruits on the tree between picks 1 and 2 in the grass and cultivated series, and in these series the fruits of the second and third picks softened more rapidly in store than did those from the ringed and not ringed series.

2. The rate of softening after picking is greater in the later picks. The figures representing the rate of softening in storage, suggest that the period between the third (the commercial) pick and the fourth pick was rather critical for the ringed-not ringed series, since softening went on much more rapidly at the fourth pick. The figures, however, may be a little misleading ; the complete curves do not show such a marked difference.

The fruits on the ringed trees softened more rapidly up to the time of the third pick than did those on the not ringed trees. This may be due to a more rapid ripening of the fruits on the ringed trees.

If, on the other hand, a higher rate of softening in storage is an index of riper fruits at picking, as seems likely since the rate increases the longer the fruits remain on the tree, the data suggest that the fruits are ripening less rapidly on the ringed trees, than those on the not ringed trees, since they soften in storage at a slower rate.

It would thus appear that in this case the pressure test does not provide guidance as to maturity at both stages considered. The use of the test as an index to picking maturity, however, has not been recommended in the case of apples, since there are too many factors which influence their hardness during ripening on the tree (13 and 24). The greater increase in size of the fruit which occurs on the ringed trees for example, may account for their more rapid softening.

Ringling causes a decrease in the amount of vegetative growth of a tree, which will mean that less food material is used in this direction ; it also restricts the movement of food materials to the roots. Providing the leaf surface is not seriously reduced thereby, it will follow that there is an increased food supply available for the fruits. This is in agreement with the fact that fruits from ringed trees are usually larger, and contain more dry matter and sugar than those from not-ringed trees, as was reported by Wallace at the Imperial Horticultural Conference (38). Thus the increased supply of materials would be associated with a slower rate of ripening of the fruits on the ringed trees, agreeing with the inferences drawn from the discussion in the introductory section.

The data from the grass-cultivated series do not allow definite conclusions relating to differential effects of the two treatments to be drawn.

Another series of grass-cultivated apples of the variety Grenadier, of which only two picks were made, were examined in the same way, and the data are drawn up in Table II.

TABLE II.
Variety—*Grenadier*.

			<i>Pick 1.</i> August 19, 1930.		<i>Pick 2.</i> August 30, 1930.	
			A	B	A	B
Cultivated	..		9.5	2.0	7.5	1.0
Grass	..	..	10.5	1.5	8.0	0.5

A = original hardness value at picking.

B = loss in hardness value after 36 days in store.

The second picking instead of softening more quickly in storage did so less quickly, but the rate of softening was extremely slow, and actually ceased quite soon, as if the fruits had already almost reached their limit of softening whilst on the tree. The variety is an early one, and this picking was made late. In addition wilting readily took place in storage, and this would increase the pressure test figure. Nevertheless, it is apparent that the fruits from the grass plot soften more slowly in storage, which is in agreement with the tendency which is seen in the figures for the first pick of the Newton series.

Here again growing under grass reduces the vegetative growth to some extent, which may result in a less restricted supply of food for the fruit. In those cases where this orchard method has produced any marked effect, the amount of sugar has in fact been increased (38). Again there is the association between increased supply and a slower rate of ripening of the fruit on the "grassed" trees.

CONCLUSIONS.

Certain tentative conclusions may be drawn from these preliminary results.

1. The rate of softening after picking is greater in later pickings of apples. One exception was found to this rule. Fruits which soften more quickly after picking are therefore possibly more mature at the time they were picked.

2. Fruits from ringed trees and from trees grown under grass soften less quickly after picking than those from comparable not-ringed trees grown under cultivation. These "ringed" and "grassed" fruits may therefore be less mature at the time of picking than the "not ringed" and "cultivated" fruits.

3. Immaturity in "ringed" and "grassed" fruits may be associated with the increased availability of food on the "ringed" and "grassed" trees, which are known to produce fruits with greater contents of solids, particularly soluble carbohydrates.

4. No definite conclusions can be drawn from the rates of softening of the apples whilst still on the trees.

REFERENCES.

- (1) APPLEMAN, C. O. and CONRAD, C. M. "Pectic Constituents of Peaches and their Relation to Softening of the Fruit." *Maryland Agr. Exp. Sta. Bull.* 283, 1926.
- (2) ARCHBOLD, H. K. "Chemical Studies in Physiology of Apples IX." *Annals Bot.* 42 : p. 541, 1928.
- (3) ARCHBOLD, H. K. "Chemical Changes in Stored Apples. Relation of Time of Picking to Chemical Composition and Storage Life of the Apple." *Proc. 1st Imp. Hort. Conf.* 1930 : p. 91, Pt. III.
- (4) BIGELOW, W. D., GORE, H. C. and HOWARD, B. J. "Studies on Apples." *U.S. Dept. Agr. Bur. Chem. Bull.* 94, 1905.
- (5) BROOKS, C., COOLEY, J. S. and FISHER, D. F. "The Nature and Control of Apple-scald." *Jour. Agr. Res.* 18 : p. 211, 1919.
- (6) BURROUGHS, A. M. "Changes in Respiration Rate of Ripening Apples." *Proc. Amer. Soc. Hort. Sci.*, 1922 : p. 225.
- (7) BURROUGHS, A. M. "Certain Physiological Changes taking place during Ripening of Wealthy, Wagner, and Baldwin Apples. Storage Investigations 1921-22." *Marble Lab. Pub.* : p. 101, 1922.
- (8) CARNE, W. M., PITTMAN, H. A. and ELLIOT, H. G. "Bitter-Pit of Apples in Australia." *Dep. Sci. Ind. Res. Comm. Australia, Bull.* 41, 1929.
- (9) CARNE, W. M., PITTMAN, H. A. and ELLIOT, H. G. "The Present Position of the Bitter-Pit Problem in Australia." *Proc. 1st Imp. Hort. Conf.* 1930 : p. 37, Pt. III.
- (10) COE, F. M., WILSON, A. L. and ABEL, T. H. *Utah Agr. Exp. Sta. Bienn. Rep.* 1928-9. (*Exp. Sta. Record* 61 : p. 37, 1929).
- (11) HALLER, M. H. "Changes in the Pectic Constituents of Apples in Relation to Softening." *Jour. Agr. Res.* 39 : p. 739, 1929.
- (12) HARLEY, C. P. "Relation of Picking Time to Acetaldehyde Content and Core Breakdown of Bartlett Pears." *Jour. Agr. Res.* 39 : 483, 1929.
- (13) HARTMAN, H. "Studies Relating to the Harvesting and Storage of Apples and Pears." *Oreg. Agr. Exp. Sta. Bull.* 206, 1924.
- (14) HARTMAN, H. "The Control of Core-breakdown in Pears." *Oreg. Agr. Exp. Sta. Bull.* 216, 1925.
- (15) HARTMAN, H., MAGNESS, J. R., REIMER, F. C. and HALLER, M. H. "Investigations on the Harvesting and Handling of Bosc Pears from the Rogue River Valley." *Oreg. Agr. Exp. Sta. Bull.* 228, 1927.
- (16) HARTMAN, H., REIMER, F. C. and NORRIS, R. K. "Further Investigations on the Harvesting, Storage, and Ripening of Pears from the Rogue River Valley." *Oreg. Agr. Exp. Sta. Bull.* 254, 1929.

- (17) HOOD RIVER RESEARCH STATION. *Oregon, Bienn. Rept.* 1926-1928.
- (18) KIKUCHI, A. "Variation in Size and Form of *Pyrus Serotina*." *Bot. Ga.* 79: p. 412.
- (19) LEWIS, C. I., MURNEEK, A. E. and CATE, C. C. "Pear Harvesting and Storage Investigations in Rogue River Valley." *Oreg. Agr. Exp. Sta. Bull.* 162, 1919.
- (20) LINDET. Quoted in Bigelow, Gore and Howard (4).
- (21) MAGNESS, J. R. "Investigations in the Ripening and Storage of Bartlett Pears." *Journ. Agr. Res.* 19: p. 473, 1920.
- (22) MAGNESS, J. R. and BURROUGHS, A. M. "Studies in Apple Storage." *Marble Lab. Pub.* 1922: p. 17.
- (23) MAGNESS, J. R., DIEHL, H. C. and ALLEN, F. W. "Investigations on the Handling of Bartlett Pears from Pacific Coast Districts." *U.S. Dept. Agr. Tech. Bull.* 140, 1929.
- (24) MAGNESS, J. R., DIEHL, H. C. and OTHERS. "The Ripening, Storage, and Handling of Apples." *U.S. Dept. Agr. Bull.* 1406, 1926.
- (25) MAGNESS, J. R. and DIEHL, H. C. "Physiological Studies on Apples in Storage." *Journ. Agr. Res.* 27: p. 1, 1924.
- (26) MURNEEK, A. E. "A New Test for Maturity of the Pear." *Oreg. Agr. Exp. Sta. Bull.* 186, 1921.
- (27) NELLER, J. R. and OVERLEY, F. L. "Physical and Chemical Characteristics of Maturing Apples as Related to Time of Harvest." *Wash. Agr. Exp. Sta. Bull.* 205, 1926.
- (28) PALMER, R. C. "Recent Progress in the Study of Jonathan Breakdown in Canada." *Proc. 1st Imp. Hort. Conf.* 1930: p. 25, Pt. III.
- (29) PALMER, R. C. "Jonathan Breakdown." *Ann. Rept. Dom. Exp. Sta. Summerland, B.C.*, 1927.
- (30) PLAGGE, H. H. and MANEY, T. J. "Apple Storage Investigations 4th Progress Report." *Iowa Agr. Exp. Sta. Bull.* 222, 1924.
- (31) PLAGGE, H. H. and MANEY, T. J. "Cold Storage Investigations with Wealthy Apples." *Iowa Agr. Exp. Sta. Bull.* 230, 1925. (*Exp. Sta. Record* 54: p. 39).
- (32) PLAGGE, H. H., MANEY, T. J. and GERHARDT, F. "Certain Physical and Chemical Changes of Grimes Apples during Ripening and the Storage Period." *Iowa Agr. Exp. Sta. Res. Bull.* 91, 1926.
- (33) POWELL, G. H. and FULTON, S. H. "The Apple in Cold Storage." *U.S. Dept. Agr. Plant Indus. Bull.* 48, 1903.
- (34) RAMSEY, H. J., MCKAY, A. W., MARKELL, E. L. and BIRD, H. S. "The Handling and Storage of Apples in the Pacific North-west." *U.S. Dept. Agr. Bull.* 587, 1917.
- (35) SMITH, A. J. M. "Bitter-Pit in Apples. A Review of the Problem." *D.S.I.R., Great Britain, Food Invest. Board. Special Rept.* 28, 1926.
- (36) ST. JOHN, J. L. and NORRIS, O. M. "Studies of Quality and Maturity of Apples." *Journ. Agr. Res.* 39: p. 623, 1929.
- (37) TILLER, L. W. "Cold Storage of Fruit." *Dep. Sc. Ind. Res., New Zealand, Bull.* 16, 1929.
- (38) WALLACE, T. "Factors Influencing the Storage Quality of Fruits." *Proc. 1st Imp. Hort. Conf.* 1930: p. 9, Pt. III.

STUDIES ON MATURITY OF FRUIT.

III.—STARCH CONTENT IN RELATION TO
MATURITY OF APPLES GROWN UNDER
VARIOUS ORCHARD CONDITIONS.

BY J. C. HINTON.

INTRODUCTION.

A brief summary of the main facts relative to maturity in apples and pears which have been previously established has been presented in the introductory section to this series, but certain of these which are particularly relevant to the special phase of the maturity problem discussed in the present paper are re-stated here.

During the later period of development on the tree, two main aspects of the metabolism of the fruits can be recognised :—

(a) A continuation in the accumulation of the various complex bodies which enter into the subsequent metabolism of the fruits and which are principally polysaccharides. The rate of this accumulation is not constant but slowly decreases.

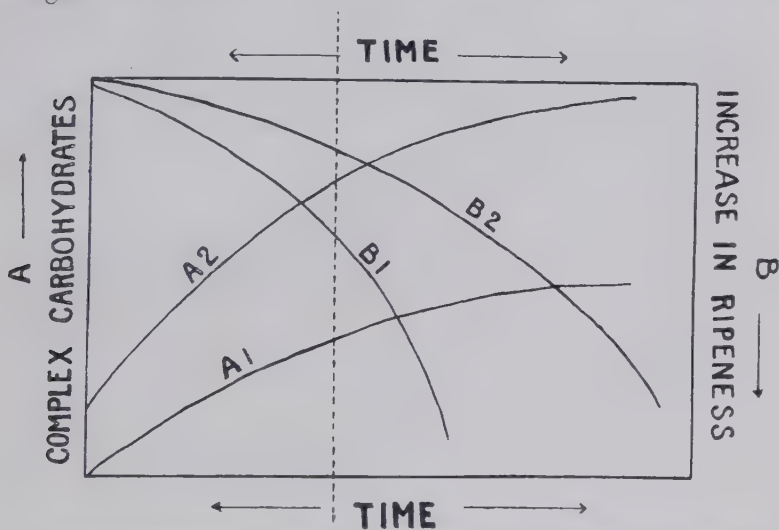
(b) A process, or a complex of processes, of hydrolysis comprising a breaking down of the various complex carbohydrate bodies to simpler respirable products. The rate of this process is also not constant, but slowly increases, and after the fruit is picked the process eventually becomes the predominant one.

In comparing two similar fruits, therefore, one of which has been picked earlier and one later, the later picked specimen is seen to have accumulated more of the complex bodies; the sucrose content, for example, is greater, and the process of hydrolysis has become more important. Moreover, after picking, the later gathered fruit matures or ripens at a more rapid rate than the earlier picked one. In each case the removal from the tree results in an increase in the rate at which ripening or hydrolysis proceeds, the increase being greater in the case of the later picked, *i.e.* more mature fruit, than in the case of the earlier picked one.

It was suggested as a working hypothesis in Part I that this increase which takes place after picking is the result of the stopping

of the food supply which picking causes, and further that the gradual increase in the rate of the hydrolysing processes, which is seen during the later period of ripening on the tree, is similarly related to the gradual decrease of the food supply which is taking place at the same time. The ripening and hydrolysing processes may be controlled to some extent by the rate at which food is supplied. A cessation of the supply would allow the ripening processes to develop, whilst a continuation of it would retard those processes. Hence any set of conditions which affected the food supply, particularly during the later period of fruit development, would influence all those aspects of fruit quality which are related to maturity.

The inter-relationship of factors may be represented by a diagram as under:—



The rising curves A1 and A2 represent the increase in complex bodies taking place during the later period of ripening on the tree, the decrease in rate being represented by the decreasing slope of the curves. The falling curves B1 and B2 represent the increase in ripeness, the increasing rate being shown by the increasing slope of the curves.

The greater decrease in the supply of food material which is indicated by the curve A1 is associated with the greater increase in the process of ripening indicated by curve B1 (case 1).

The continuation of the food supply represented on the other hand by curve A2 is associated with the delay in ripening represented by curve B2 (case 2).

In comparing fruits from these two cases at any given date, as represented by the broken vertical line, it will be obvious that in case 2 there is a greater accumulation of complex bodies associated with a less ripe fruit than in case 1.

Comparison of fruits at different dates but within the same case, would show, on the other hand, a greater accumulation of complex bodies associated with a riper fruit.

The difference in ripeness it will be recalled is shown both by the degree of ripening attained on the tree, and the rate at which ripening proceeds after removal from the tree.

The work described in the present paper comprises one aspect of a more general investigation into the factors affecting fruit quality which is in progress at Long Ashton. The general investigation has involved the carrying out of storage tests and the estimation of certain chemical constituents on many samples of fruits, all of which had been grown under conditions where factors exercising dominating effects on fruit quality were present. The particular aspect presented here is concerned with what may be described broadly as the maturity problem of these samples. In an endeavour to assess the relative stages of maturity of samples selected for comparison, use was made of the starch-iodine test at the time of picking, and in those cases where the quantity of material was sufficient, at two or three subsequent points during storage.

The starch-iodine test has been used recently with success by Carne (2) as an index of maturity in studies on the control of bitter-pit. It depends upon the fact that the loss of starch which occurs during the ripening of an apple does not take place uniformly throughout the tissue, as was shown by Bigelow, Gore and Howard (1). By dipping the freshly cut transverse surface of a fruit into a solution of iodine (0.25% iodine in 1% potassium iodide) the distribution of the starch can be seen and a rough estimate formed of the quantity present. When the cut is made transversely across the middle of the fruits, it is seen that in the early stages starch is distributed evenly throughout the tissue. As ripening proceeds it is lost first at the centre, and the loss spreads outwards gradually through the whole of the core region. In the tissue outside the core, however, this steady advance of the clear areas towards the circumference is not so obvious. In this region the tissue lying in between the many vascular strands loses its starch first, while that immediately surrounding the vascular strands retains its starch for some time and stands out as a strong dark pattern when stained by the iodine. This tendency is less marked when this stage of ripening takes place off the tree than when it

takes place on the tree, in the former case the loss being a little more uniform throughout the whole of the region external to the core. It is also less marked in some varieties, *e.g.* Bramley's Seedling and Newton Wonder, than in others. The starch is eventually lost from all tissues, persisting longest in those nearest the skin. Plate I, Figs. 1 to 6, illustrate the stages of starch loss from apples.

Under favourable circumstances the knowledge of this sequence of events may be used to form an estimate of the stage of ripeness of any given sample of fruit. It was one of the aims of this work to test the use of this maturity index in this way in comparing the ripeness of fruits from various orchard treatments and one or two difficulties in its use for this purpose have been recognised during the investigations.

The quantity of starch in some samples is greater than in others, as is shown by the deeper and more intense colour of the stained fruits. When comparisons are being made, this deeper deposit may mask the extent to which starch disappearance has progressed in the samples with high starch content. This factor becomes more important in those varieties in which the starch is lost more evenly throughout the tissues. In the varieties in which the tissues around the vascular strands retain their starch, producing a strong pattern, the extent that starch disappearance has reached is more readily estimated despite differences in intensity of the deposit.

The variability within any sample also needs consideration. Ten to fifteen fruits have always been used in this work upon which to base conclusions relative to maturity, and numbers of these orders are the smallest that should be allowed. Greater variation between individual fruits of a sample has usually been found in samples which have lost their starch to a greater extent and were in this respect more mature.

Difficulty was also experienced in certain cases owing to the fact that fruits had lost starch completely from half or some portion of the transverse section whilst retaining it fully in the remaining portion. In such cases it was usually the green side of the fruit from which starch had disappeared.

Such difficulties decrease the value of the starch test as an index of ripeness, and it seems desirable only to place reliance on the conclusions drawn from the use of it in the cases where the indications are definite and the differences well marked.

The use of the test during the storage period as an index of the rate at which apples are maturing after picking is probably much more satisfactory. Differences in the rates at which samples lose

their starch are readily detected by the test, as can be seen in Plate II, Figs. 1 to 6, which represent three tests made at intervals during storage on samples 23 and 24 in the Table.

It is not definitely established that the rate at which starch is lost is a complete index of the rate at which apples are maturing, but it is at least true that hydrolysis of starch is one of the processes of maturation. The fact that the rate of starch disappearance may not be an entirely accurate index of maturity must be borne in mind in considering some of the less significant differences discussed later in the paper.

EXPERIMENTAL.

Samples for starch tests were mainly chosen in pairs so that the members of the pair differed from each other in only one respect. Thus it would be recorded that a sample of fruits which had been thinned was more, or less, ripe than a sample which had not been thinned but was otherwise similar in all respects. Photographs of several samples which had been cut and stained, illustrative of the material from which such records have been made, are presented in Plates II -III. Significant observations made in this way, together with data relative to the contents of dry matter, sucrose, and hexoses for various samples, are summarised in Table I, the samples being considered by groups with respect to the orchard treatment involved. The aim in making this examination was to ascertain to what extent greater availability of food, as indicated by a higher content of dry matter and of sugars, was associated with a less ripe condition of the fruits.

The loss of total weight in the case of each sample of fruits has been obtained during a period in cold storage at 1°C and 95% relative humidity, and the figures so obtained are included in the Table. Fruits picked relatively late, it will be recalled, have been reported to lose in total weight at a slower rate than those which were picked earlier and which were therefore less mature at picking. In the present case, however, no consistent conclusions relating to this point can be drawn. In some cases, samples, which from other indications would be considered more mature, lost less weight than those with which they were compared, in accordance with the previously reported results, but in others the reverse was the case. The differences between the amounts lost by the various samples compared, however, are very small, as is the whole loss under cold storage conditions; it may be desirable to have conditions which would produce larger differences.

The figures representing the acid contents gave no relevant information and for this reason are not presented.

The ratio of $\frac{\text{Sucrose}}{\text{Hexoses}}$ is included since in some circumstances it may be a further index of the stage of maturity of a sample of fruits. It was mentioned in the previous paper (No. 1 of this series) that Archbold reported that there was a period near the normal picking date during which hexoses increased at a faster rate than did the sucrose in fruits of Bramley's Seedling which were ripening on the tree. Thus a lower ratio of $\frac{\text{Sucrose}}{\text{Hexoses}}$ *during this period* would be associated with more mature fruits, and if this is applicable to other varieties, the ratio may be an additional index in the study of maturity of fruits.

The data presented in Table I thus show, for example, that in samples 1 and 2 a thinned and an unthinned sample of Early Victoria apples, the content of dry matter is 11.85 in the thinned against 10.78 in the unthinned, of sucrose 2.3 against 1.95, of hexoses 4.7 against 5.2, and the ratio of $\frac{\text{Sucrose}}{\text{Hexoses}}$ 0.490 against 0.375; the starch records state that the disappearance has not reached such an advanced stage in the thinned as it has in the unthinned sample, the regions in between the vascular strands being still clouded in the thinned, whilst being clear in the unthinned. In this case, therefore, it would seem to be true that the greater availability of food material is associated with less ripe fruit.

This particular case is of special interest since thinning was carried out only 14 days prior to picking, actually taking the form of a preliminary "picking over" for early market. The average fruit weight at the final picking was scarcely affected thereby, the thinned sample being 2% heavier than the control. Nevertheless, the contents of sucrose and dry matter are increased considerably, accompanied by the retardation of ripening. This suggests that it is during the later period of growth and ripening that an increase in the food supply within the tree is mainly effective in retarding the maturing processes.

TABLE I.

A SUMMARY OF OBSERVATIONS ON THE MATURITY OF SAMPLES OF APPLES GROWN UNDER DISTINCTIVE ORCHARD CONDITIONS IN RELATION TO CERTAIN CHEMICAL AND OTHER DATA (1929 CROP).

Sample No.	Variety.	Special Treatment.	Locality.	Per cent loss in weight in cold store.	Dry weight as per cent fresh weight.	As per cent. fresh weight.			Ratio Sucrose Hexoses.	Maturity as determined by observations on starch distribution.
						Total Sugars as Invert.	Sucrose.	Hexoses.		
1	Early Victoria	Thinned	Somerset	7.6	11.85	7.0	2.3	4.7	.490	Thinned are less mature than the unthinned. (The former show no clear areas.)
2	"	Not thinned	"	7.3	10.78	7.3	1.95	5.2	.375	
3	Bramley's Seedling	Thinned	Kent	3.91	12.25	10.6	2.5	7.9	.313	Thinned sample is a little less mature.
4	" (ringed)	Not thinned	"	4.03	13.16	10.5	2.7	7.6	.355	Thinned sample is a little less mature.
5	Bramley's Seedling	Thinned	Kent	3.56	11.50	9.45	2.3	6.9	.333	
6	" (not ringed)	Not thinned	"	4.16	12.00	9.87	2.2	7.6	.290	Thinned sample is a little less mature.
7	Bramley's Seedling	Thinned	Kent	4.08	14.37	11.98	2.85	8.9	.320	Thinned sample is a little less mature.
8	"	Not thinned	"	3.29	14.55	11.57	2.35	9.1	.250	
9	Bramley's Seedling	Normal	Kent	4.16	12.0	8.22	2.26	5.84	.387	Potash-deficient more mature. (1)
10	"	Potash-deficient	"	5.53	11.14	9.58	1.86	7.62	.244	Potash-deficient more mature. After some time in storage, normal has appreciable amount of starch deficient is quite clear. (1)
11	Newton Wonder	Normal	Kent	5.31	12.65	10.43	1.95	8.47	.230	
12	"	Potash-deficient	"	7.48	12.20	9.83	1.59	8.16	.195	Potash-deficient more mature (no starch present at all normal contains usual deposits of starch).
13	Allington Pippin	Normal	Somerset	7.46	14.0	11.90	3.50	8.24	.425	Potash-deficient more mature.
14	"	Potash-deficient	"	6.60	10.65	9.50	1.62	7.80	.208	
15	Grenadier	Normal	Lancashire	8.69	11.21	9.78	1.74	7.94	.219	There is no definite difference in maturity of the two samples. The deficient series are more variable and may therefore be more mature.
16	"	Potash-deficient	"	9.22	10.0	8.26	1.12	7.07	.158	
17	Monarch	Normal	Essex	6.77	14.2	11.25	2.05	9.09	.225	Potash-deficient are more mature.
18	"	Potash-deficient	"	5.06	13.65	11.13	1.23	9.84	.125	
19	Bismarck	Normal	Lancashire		14.7	9.74	1.93	7.7	.250	
20	"	Potash-deficient	"	—	12.45	9.58	1.59	7.9	.201	

TABLE 1.—Continued.
A SUMMARY OF OBSERVATIONS ON THE MATURITY OF SAMPLES OF APPLES GROWN UNDER DISTINCTIVE ORCHARD CONDITIONS IN RELATION TO CERTAIN CHEMICAL AND OTHER DATA (1929 CROP).

Sample No.	Variety.	Special Treatment.	Locality.	Per cent loss in weight in cold store.	Dry weight as per cent fresh weight.	As per cent. fresh weight.			Ratio Sucrose Hexoses.	Maturity as determined by observations on starch distribution.
						Total Sugars as Invert.	Sucrose.	Hexoses.		
21	Grenadier	Normal	Herefordshire	8.18	11.0	7.08	1.80	5.19	.347	Potash-deficient sample distinctly more mature.
22	"	Potash-deficient	"	10.21	9.34	7.05	1.45	5.53	.262	
23	Allington Pippin	Grass	Somerset	6.95	12.88	11.30	3.17	6.93	.460	Cultivated more mature. Difference is small at picking time. During storage cultivated lose starch more rapidly than grass. (See Plate II., Figs. 1—6.)
24	"	Cultivated	"	7.35	12.05	10.83	3.04	6.61	.460	
25	Newton Wonder	Grass	Herefordshire	7.09	13.94	10.04	2.44	7.45	.327	Difference only small. Cultivated probably more mature. During storage cultivated lose starch more rapidly than do grass. (2) (7).
26	"	Cultivated	"	6.60	12.68	8.91	2.12	6.69	.317	
27	Newton Wonder	Grass	Herefordshire	7.16	12.45	11.14	2.80	8.18	.342	Grass a little more mature. Cultivated may be losing starch a little faster during storage. (7)
28	"	Cultivated	"	7.66	11.89	9.85	2.50	7.22	.346	
29	Newton Wonder	Grass	Somerset	4.95	13.63	9.60	1.52	7.99	.190	No difference in maturity can be detected at picking time. During storage the cultivated lose starch more rapidly than do the grass.
30	"	Cultivated	"	5.37	12.54	8.90	1.31	7.51	.174	
31	Lord Grosvenor	Grass	Herefordshire	6.35	12.58	8.71	2.03	6.53	.311	Cultivated are more mature, and lose starch more rapidly during storage than the grass. (8)
32	"	Cultivated	"	3.17	10.68	7.70	1.33	6.02	.221	
33	Lord Grosvenor	Grass	Herefordshire	5.74	11.30	9.38	2.30	6.82	.337	Grass may be more mature at picking. During storage cultivated lose starch more quickly than do grass. (8)
34	"	Cultivated	"	5.32	10.80	7.93	1.46	6.41	.228	
35	Worcester Pearmain	Grass	Somerset	8.18	15.75	11.11	2.55	8.43	.302	Cultivated are slightly more mature. During storage cultivated lose starch more quickly than do grass.
36	"	Cultivated	"	7.20	13.88	10.20	2.10	8.0	.262	
37	Bramley's Seedling	Grass	Kent	—	11.45	8.75	1.96	6.69	.293	Grass more mature. (2)
38	"	Cultivated	"	—	11.85	8.24	2.26	5.84	.387	
39	Bramley's Seedling	Ringed	Kent	6.37	12.30	10.48	2.05	8.30	.247	Very little difference; ringed may be more mature.
40	"	Not ringed	"	5.53	11.14	9.58	1.86	7.60	.245	(3) (5)
41	Newton Wonder	Ringed	Kent	8.17	12.80	10.13	1.70	8.30	.204	Very little difference; ringed may be more mature (5)
42	"	Not ringed	"	7.48	12.20	9.83	1.58	8.16	.194	
43	Newton Wonder	Ringed	Kent	5.19	13.40	10.76	1.88	8.80	.213	Very little difference; ringed may be more mature.
44	"	Not ringed	"	5.31	12.65	10.53	1.95	8.47	.230	

A SUMMARY OF OBSERVATIONS ON THE MATURITY OF SAMPLES OF APPLES GROWN UNDER DISTINCTIVE ORCHARD CONDITIONS IN RELATION TO CERTAIN CHEMICAL AND OTHER DATA (1929 CROP).

Sample No.	Variety.	Special Treatment.	Locality.	Per cent loss in weight in cold store.	Dry weight as per cent fresh weight.	As per cent fresh weight.			Ratio Sucrose Hexoses.	Maturity as determined by observations on starch distribution.
						Total Sugars as Invert.	Sucrose.	Hexoses.		
45	Ellison's Orange	..	Essex		18.55	15.23	3.70	11.33	.328	Ringd sample contains larger number of riper fruits, therefore may be more mature than the not ringd
46	"	..	"		18.70	15.10	3.81	11.10	.343	
*47	Newton Wonder	..	Herefordshire	6.30	12.46	9.51	1.90	7.5	.253	Ringd 1929 least mature; not ringd most mature; ringd 1928 intermediate between the other two. During storage not ringd and ringd 1928 lose starch before ringd 1929. (9)
*48	"	..	"	7.32	13.28	10.06	1.80	8.13	.221	
*49	"	..	"	7.07	12.37	9.57	1.55	7.95	.195	
50	Newton Wonder	..	Herefordshire	5.40	12.92	10.30	1.80	8.4	.214	At picking ringd 1928 is most mature; ringd 1929 is least mature; not ringd is a little more mature than 1929. During storage ringd 1928 and not ringd lose starch faster than ringd 1929. (4) (9)
51	"	..	"	6.90	14.47	11.25	2.65	8.46	.313	
52	"	..	"	7.39	11.70	10.26	2.05	8.10	.253	
53	Bramley's Seedling	..	Somerset	3.47	12.15	8.50	2.15	6.24	.345	Ringd 1929 less mature than ringd 1928 and not ringd. (4)
54	"	..	"	3.87	14.60	9.57	2.95	6.50	.454	
55	"	..	"	3.46	12.35	8.70	1.90	6.70	.284	
56	Bramley's Seedling	..	Kent	4.21	12.55	10.40	2.17	8.10	.268	No. 5 are more mature.
57	"	..	"	3.93	13.98	11.88	3.25	8.45	.385	
58	Bramley's Seedling	..	Kent	—	12.70	10.80	2.36	8.30	.284	No. 5 are more mature. (6)
59	"	..	"	—	13.55	11.83	2.70	9.0	.300	
*60	Worcester Pearmain	..	Somerset	7.77	14.25	10.91	2.82	7.95	.355	No. 5 are least mature; the remainder are about equal.
*61	"	..	"	9.55	14.50	11.12	2.74	8.23	.333	
*62	"	..	"	9.77	14.52	10.77	2.54	7.88	.322	
*63	"	..	"	8.57	15.51	11.66	3.14	8.35	.375	

(1) Potash-deficient sample has a lighter deposit of starch than normal.

(2) Cultivated have heavier deposit of starch than grass.

(3) Ringd have heavier deposit of starch than not ringd.

(4) Ringd 1929 have heavier deposit of starch than ringd 1928 and not ringd.

(5) Samples 39, 40, 41 and 42 are potash-deficient in addition to other treatments.

(6) Samples 58 and 59 are to some extent potash-deficient.

(7) Samples 25 and 26 were picked October 7, 1929; Samples 27 and 28 are from the same experiment but were picked October 21, 1929.

(8) Samples 31 and 32 were picked September 11, 1929; Samples 33 and 34 are from the same experiment but were picked September 20, 1929.

(9) Samples 47, 48 and 49 were picked October 7, 1929; Samples 50, 51 and 52 are from the same experiment but were picked October 21, 1929.

* Denotes samples which are not in agreement with the suggested hypothesis.

DISCUSSION.

Of the cases considered in Table I. twenty-one are in agreement with the hypothesis of a relationship between maturity and food supply and eight are contrary to it. These latter cases are marked *. Attention is drawn to the fact, however, that in some cases where it has been possible to continue observation of the starch deposit during the storage period, samples which were apparently at an equal stage of ripeness as judged by the starch test at picking time, have behaved differently in storage. Thus in samples No. 29 and 30 of the variety Newton, and 33 and 34 of the variety Grosvenor, the starch test as applied at picking time gave no definite information as to differences in degree of ripeness, but after some time in store the cultivated samples had lost all their starch, whilst the grass still contained appreciable quantities. A quicker rate of ripening during storage, which will involve a more rapid hydrolysis of starch, as has already been indicated, is an index of fruits which were riper at picking time. It is obviously desirable to be able to carry out observations in this way during the storage period if definite information as to the maturity of various samples of fruits is to be obtained.

The cases which are marked are those in which the stage of ripeness as indicated by the starch test at picking time is contrary to the inferences drawn from the other data, such, for example, as samples 41 and 42 in which a ringed sample was considered to be more mature than the corresponding control, although it had a higher content of dry matter and sucrose, and a higher ratio of $\frac{\text{Sucrose}}{\text{Hexoses}}$. Comment can only be offered in the case of samples 60 to 63, in which the variety Worcester Pearmain from trees on four different root stocks are compared. The fruits here are not representative samples of the crop but represent a preliminary picking for early market, for which reason they may not be strictly comparable. In the other cases further information is needed before a true interpretation of the facts observed can be reached.

Some of the other samples, however, in which there is not this type of disagreement between the data obtained, are worthy of comment. Samples 5 and 7, representative of two thinning experiments, are found to have a smaller content of dry matter than their controls, but have, however, more sucrose and a greater ratio of $\frac{\text{Sucrose}}{\text{Hexoses}}$ and are considered to be less mature. It is more usual to find the latter conditions associated with a *higher* content of dry matter.

Samples 3 and 4 are from a thinning experiment in which the thinned fruits have less dry matter and sucrose than the unthinned, a result which is contrary to that normally obtained from fruit thinning. Both samples had been obtained from trees which had been ringed, and it is impossible to say how far this factor may be responsible for the unusual result from fruit thinning. Ringing and thinning introduce certain similar factors which result, in general, in increased food supply for the growing fruit. The effect of ringing varies from tree to tree depending upon the extent to which the ring has healed over, and the original internal condition or "vigour" of the tree. It is thus possible that the effects from the rings on the "unthinned" trees were greater than those on the thinned trees, sufficiently so to place the unthinned fruits in a more favourable position with regard to food supply than the thinned fruits in spite of the thinning treatment.

The various ringing experiments are particularly difficult to interpret. In samples 47, 48 and 49, which are from a preliminary but strictly representative picking of the same fruits as in samples 50, 51 and 52, sample 48, ringed in the same year as the fruits were picked, shows a disagreement between its content of sucrose and ratio $\frac{\text{Sucrose}}{\text{Hexoses}}$ and the other data. Sample 51, which represents the same type of fruits picked at a later date, does not show this disagreement. It would be desirable to repeat this experiment.

In samples 43, 44, and 45, 46 from two ringing experiments, the data uphold the hypothesis, but the results of the ringing are not the usual ones. The ringed fruits are seen to have *less* dry matter and sucrose, and a lower ratio $\frac{\text{Sucrose}}{\text{Hexoses}}$ than the control, which is the reverse of the results usually obtained from ringing. (See Wallace (3)).

It may be worthy of note that samples 39 to 46 in the "ringed" section, and samples 3 to 8 in the "thinned" section, none of which have produced completely understandable results, are from orchards in the Eastern counties of England.

Samples 37 and 38 are unlike the rest of the group of "grass" experiments. The "grassed" fruits in this experiment contain less solids and sucrose and are more mature. This is completely intelligible, however, since the "grassed" trees were making exceptionally poor growth and had very pale and scanty foliage. Food supply for the fruits, which is dependent upon leaf activity, would be much below normal in this case. The result is not unusual under such conditions. The experiment was also in the east of

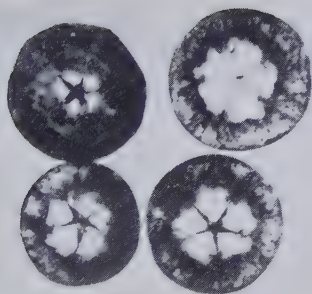


FIG. 3

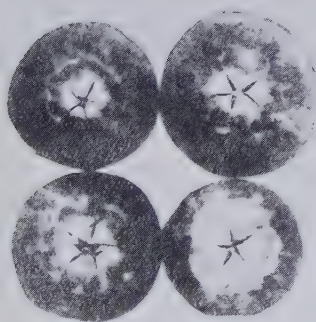


FIG. 2

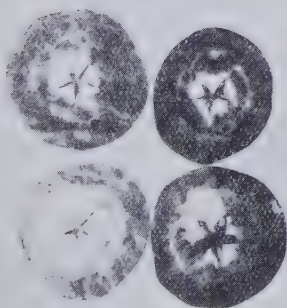


FIG. 1

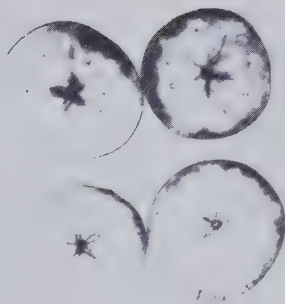


FIG. 6

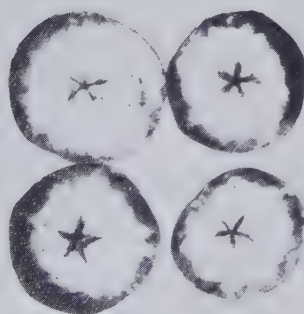


FIG. 5

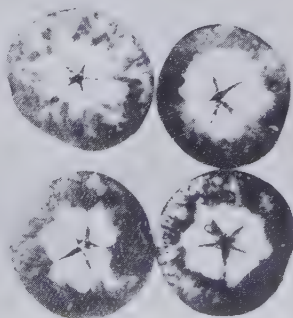


FIG. 4

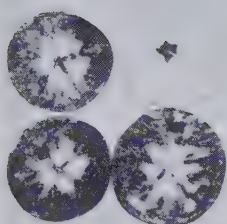


FIG. 1

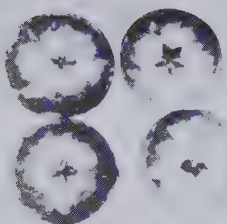


FIG. 2

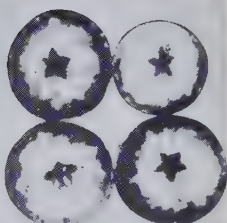


FIG. 3

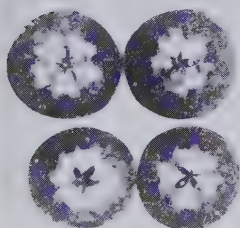


FIG. 4

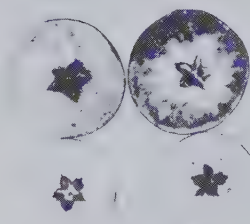


FIG. 5

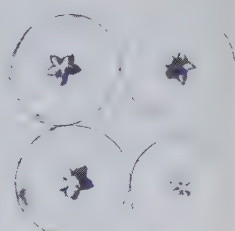


FIG. 6

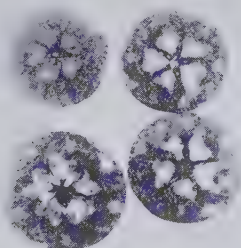


FIG. 7



FIG. 8

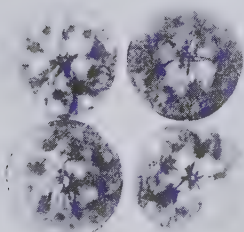


FIG. 9

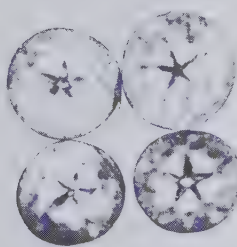


FIG. 10

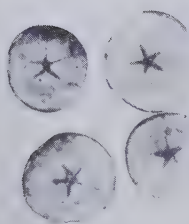


FIG. 1

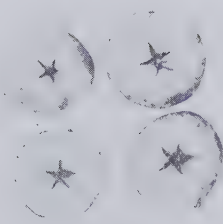


FIG. 2

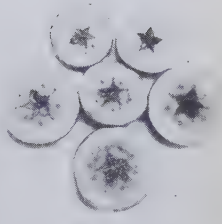


FIG. 3

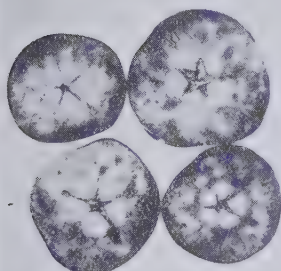


FIG. 4

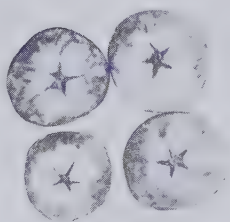


FIG. 5

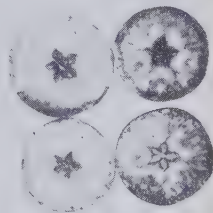


FIG. 6

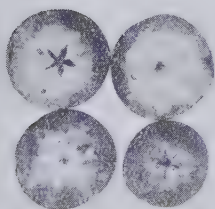


FIG. 7



FIG. 8

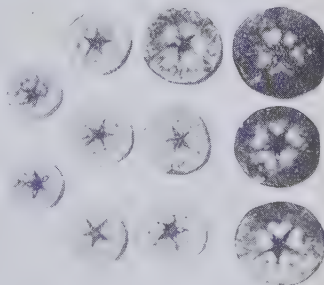


FIG. 9

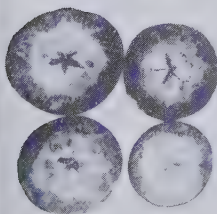


FIG. 10

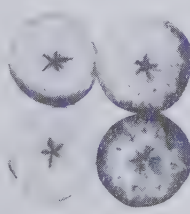


FIG. 11

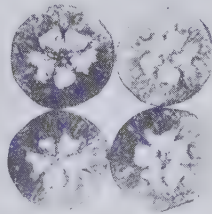


FIG. 12

England, in contrast to the rest of the grass experiments which were in the west.

Fairly consistent agreement is obtained between the samples in the "potash deficient" and "grass orchard" groups. With the exception of the sample already discussed, the trees growing under grass, in all cases, were growing sufficiently well to maintain an efficient leaf surface, nitrate being applied where necessary to ensure a healthy condition. The trees which suffered from potash deficiency were, in all cases considered, affected to such an extent that the foliage suffered from leaf scorch in the later part of the season, a condition which would inevitably interfere with the synthesising activity of the leaves and hence the supply of food. This is apart from any effect which lack of potassium may have on the photo-synthetic processes themselves.

CONCLUSION.

Before summing up the results of this general survey, it may be interesting to note that in no cases did the samples which were tested at picking time with the starch test develop any significant amount of bitter-pit in storage. This was in spite of the fact that samples at varying stages of picking maturity were included, and would suggest that bitter-pit does not inevitably follow as a result of picking apples before they are sufficiently ripe.

It may also be pointed out that the rate at which starch disappears from apples during storage, as indicated by the starch test, is different in different samples, and that this rate may be a useful index of the rate at which the fruits are maturing.

To sum up, the aim of this investigation has been to collect information from many samples of apples relative to (a) the stage of ripeness at which they were picked, and (b) the contents of dry matter and sugars, these being an indication of the extent of the food supply. Hence a comparison of these two sets of data should show to what extent a favourable food supply was associated with slowly ripening fruits. Estimates of the stage of ripeness of the samples have been obtained largely from observations on the extent to which starch has disappeared from the tissue of the fruit, as shown by the iodine test. Difficulties have been recognised in the use of this test in this way, especially when applied at only one stage in the history of the fruit—at picking time. Differences in the intensity of the starch deposit and variation between individuals are two factors which cause difficulty in the use of the test, and more detailed examination is desirable in the cases where such difficulties are encountered.

Always bearing in mind this difficulty in obtaining adequate information relative to the stage of maturity of these samples, it may be said that a correlation between food supply favourable to the developing fruits and relative immaturity of the latter has been found in many cases. In some cases, in particular, certain of the samples from the "thinning" and "ringing" experiments, the results are contrary to such a correlation. In these samples, however, potash deficiency has been involved in addition to thinning and ringing, and the results are those of a complex of these factors. This may account for the unusual results obtained from the experimental treatments themselves. More detailed examination than has been possible in this general survey would be desirable in these cases. The simple and definite examples of thinning and ringing, however, and almost all the samples from the potash-deficient and grass orchard experiments are in agreement, and exhibit the aforementioned correlation.

Thus, although the results are by no means conclusive, it is seen that in the majority of cases considered, fruits which had been growing under conditions of relatively favourable food supply are apparently ripening at a slower rate than comparable fruits which had not had such a favourable supply. Further investigation carried out in more detail than has been possible in this wide survey, and attention to the course of events in storage in conjunction with those taking place on the tree, should yield more information on this point.

ACKNOWLEDGMENT.

Thanks are due to Messrs. V. L. S. Charley and J. O. Jones, of this Station, who have supplied the chemical data contained in this paper.

REFERENCES.

- (1) BIGELOW, W. D., GORE, H. C., and HOWARD, B. J. "Studies on Apples." (*U.S.D. A. Bur. Chem. Bull.* 94, 1905).
- (2) CARNE, W. M., PITTMAN, H. A., and ELLIOTT, H. G. "Bitter-pit of Apples in Australia." (*Dep. Sci. Ind. Res. Comn. Australia. Bull.* 41, 1929).
- (3) WALLACE, T. "Factors influencing the Storage Qualities of Fruits." (*Proc. 1st Imp. Hort. Conf. Part III.* 1930).

PLATE I.

FIGS. 1 to 6. Six stages in the disappearance of starch from apples as seen when the transverse section is treated with a solution of iodine.

Note the manner in which the starch disappearance progresses from the inner to the outer regions of the fruits, particularly in the core region.

PLATE II. (*See Table I.*)

- FIG. 1. Allington Pippin, grass, (Sample 23, Table I) tested October 4th, 1929.
 „ 2. Allington Pippin, grass, (Sample 23, Table I) tested during storage October 15th, 1929.
 „ 3. Allington Pippin, grass, (Sample 23, Table I) tested during storage November 5th, 1929.
 „ 4. Allington Pippin, cultivated, (Sample 24, Table I) tested October 4th, 1929
 „ 5. Allington Pippin, cultivated, (Sample 24, Table I) tested during storage October 15th, 1929.
 „ 6. Allington Pippin, cultivated, (Sample 24, Table I) tested during storage November 5th, 1929.
 „ 7. Worcester Pearmain, cultivated, (Sample 36, Table I) tested September 13th, 1929.
 „ 8. Worcester Pearmain, cultivated, (Sample 36, Table I) tested during storage September 22nd, 1929.
 „ 9. Worcester Pearmain, grass, (Sample 35, Table I) tested September 13th, 1929.
 „ 10. Worcester Pearmain, grass, (Sample 35, Table I) tested during storage September 22nd, 1929.

NOTES.—Apples from the cultivated series in both cases are losing starch more rapidly during storage than those from the grass series.

The individual fruits composing each figure also illustrate the range of variation experienced within each sample.

PLATE III. (*See Table I.*)

- FIG. 1. Bramley's Seedling, grass, (Sample 37, Table I) tested October 14th, 1929.
 „ 4. Bramley's Seedling, cultivated, (Sample 38, Table I) tested October 14th, 1929.
 „ 2. Bramley's Seedling, not thinned, (Sample 6, Table I) tested October 14th 1929.
 „ 5. Bramley's Seedling, thinned, (Sample 5, Table I) tested October 14th, 1929.
 „ 3. Allington Pippin, potash-deficient, (Sample 14, Table I) tested October 19th, 1929.
 „ 6. Allington Pippin, adequate potash, (Sample 13, Table I) tested October 19th, 1929.
 „ 7. Newton Wonder, grass, (Sample 27, Table I) tested October 22nd, 1929.
 „ 8. Newton Wonder, grass, (Sample 27, Table I) tested during storage November 11th, 1929.
 „ 10. Newton Wonder, cultivated, (Sample 28, Table I) tested October 22nd, 1929.
 „ 11. Newton Wonder, cultivated, (Sample 28, Table I) tested during storage November 11th, 1929.
 „ 9. Bismarck, potash-deficient, (Sample 20, Table I) tested October 19th, 1929.
 „ 12. Bismarck, adequate potash, (Sample 19, Table I) tested October 19th, 1929.

NOTES.—Figs. 1, 4, grass more mature than cultivated ; Figs. 2, 5, not thinned more mature than thinned ; Figs. 3, 6, potash-deficient more mature than fruits with sufficient potash ; Figs. 7, 8, 10, 11, cultivated are losing starch more quickly than grass in store ; Figs. 9, 12, potash-deficient more variable starch content and more mature than high potash.

The four or more individual fruits composing each figure also illustrate the amount of variation experienced within each sample.

FURTHER OBSERVATIONS ON THE INFLUENCE OF POSITION IN THE CLUSTER ON THE QUALITY OF APPLES.

BY J. C. HINTON, J. O. JONES AND F. C. LEWIS.

Some preliminary observations on this subject were included in the Annual Report for 1929. Since then several isolated references in the literature to the influence which position in the cluster may have on the quality of the fruit have been noted, but no definite investigation of it appears to have been undertaken up to the present. The original observations have therefore been extended as opportunity has permitted, and as a result more detailed information has been collected.

The variation in shape between lateral and terminal fruits which was pointed out in the previous report has been noticed also by Whipple (8), who made measurements on three varieties which showed that the length of the fruits decreased in order from the apical to the lowermost one on the cluster. At the same time the length of the stalks increased. No observation on keeping quality or chemical composition, however, were made.

Ranker (6) also points out that the variety Delicious which is noticeably long is almost always a terminal fruit since it tends to be self-thinning to one apple, the terminal one, per cluster.

The terminal flower often sets more readily than the laterals, and Detjen and Gray (3) have shown that the degree to which this preferential setting takes place varies under different conditions. In cases where there is a reduced set of terminals, they consider the effect as probably due to the killing by frost of the earlier opening terminal flowers.

Varietal differences in the degree to which terminals predominate are well known. Figures are available at Long Ashton which show that in the cases of Edward VII and Bramley's Seedling, crops contain approximately equal proportions of terminal and lateral fruits, whilst in James Grieve and Allington Pippin, only 20 to 25 per cent. of terminals is usual. This indicates only a slight advantage in the setting of terminals in the latter varieties, since there is one terminal flower to five laterals. In the course of the observations made at Long Ashton, it has become obvious also that

terminal fruits are to be found more often in clusters borne on spurs than in those borne on the long twigs, though this is not so noticeable on trees or parts of trees which are very vigorous.

Carne, (2) in the course of investigations into the control of bitter-pit, observed that the large terminal apple of the cluster was particularly susceptible to bitter-pit, and concludes that it is less mature than the lateral apples.

Heinicke (4) has shown that lateral apples are much more liable to be affected by bitter-pit than terminals whilst on the tree. This is not necessarily a contradiction of Carne's statement, since the latter was dealing with bitter-pit which developed in store, and it is likely that the factors concerned in its development in store are not the same as those concerned in its development on the tree. Carne in fact considers this to be so, and draws a distinction between the disorder which occurs on the tree, and that which occurs in store, reserving the term bitter-pit for the latter (1). Heinicke advances no evidence relating to the storage condition.

There are thus sufficient observations on record to suggest that a more detailed examination would be profitable.

The work relating to terminal and lateral fruits described in this paper has included an examination of certain of the chemical constituents and their history during the storage life. Advantage was also taken of a fruit thinning experiment which was in progress on the variety Bramley's Seedling to gain further information on the chemical composition and on the effect of thinning on the composition and quality of lateral and terminal fruits. The matter has therefore been divided into two sections as follows for convenience of treatment :—

- (a) Some chemical features of terminal and lateral fruits ; and the effects of storage on the fruits and on certain chemical constituents.
- (b) The effect of fruit thinning on the composition of terminal and lateral fruits.

(a) Some Chemical Features of Terminal and Lateral Fruits ; and the Effect of Storage on the Fruits and on certain Chemical Constituents.

These observations were carried out on the variety Allington Pippin, and a sub-division into fruits from spurs and fruits from long twigs was made in addition to that into lateral and terminal fruits. The trees from which the fruits were taken were about 10 years old, were growing under clean cultivation and were receiving spur pruning treatment. The fruits, which had been labelled for

identification earlier in the season, were picked on October 20th, 1930, the normal commercial picking date, and were held in a common store at an average temperature of 10°C. Six samples were taken during the storage period up to February 9th, 1931, after which date excessive decay interfered with sampling.

The loss of total weight was determined during storage on 15 individual fruits of each series, and the average calculated as percentage loss.

The chemical analyses were made on a water extract of the frozen and pulped fruit, sugars being estimated according to Lane and Eynon's methylene blue method (5), 10 per cent. citric acid being used for inversion of sucrose, and acid by titration with N NaOH

20

Loss of Total Weight in Storage.

The figures presented in Table I show the loss in grams per 100 grams of apple for the times indicated.

TABLE I.

			After 60 days.	After 90 days.	After 180 days.
Lateral	Spur ..		8.8	15.2	23.2
	Long twig ..		8.8	14.0	21.6
Terminal	Spur ..		7.6	12.0	16.8
	Long twig ..		6.0	9.2	16.4

The complete curves which have been prepared suggest that the difference between the spur and long twigs group may not be significant since they cross over one another. The group differences of laterals and terminals are, however, quite distinct, the curves falling apart immediately.

This greater loss which the lateral fruits experience is indicated in the greater shrivelling which they undergo.

The Behaviour of the Sugars and Acid.

In calculating the content of sugars and of acid, account has been taken of the loss in weight taking place in storage, since the greater loss which takes place from the lateral fruits might have masked

somewhat any possible changes which take place in the sugar and acid contents. The figures are therefore expressed as percentages of the original fresh weight of the apples when they were put into store.

A summary of the data is presented in Table II. Owing to shortage of material, it was not possible to take a composite sample of a large number of fruits, so that although only average specimens were used for analysis, the smaller variations observed in the data are not considered to be significant. Thus the increase in sucrose in three of the series between the 60 and 90 day period is most likely due to the error of sampling, as also are the differences between

TABLE II.

		At picking.			After 30 days.			After 60 days.			After 90 days.		
		Suc-rose.	Hex-oses.	Acid.	Suc-rose.	Hex-oses.	Acid.	Suc-rose.	Hex-oses.	Acid.	Suc-rose.	Hex-oses.	Acid.
Terminal	Lateral {												
	Spur	2.10	9.4	0.67	2.0	8.4	0.64	0.96	8.7	0.52	1.0	8.2	0.45
	Long twig	2.20	9.6	0.77	1.60	8.3	0.57	0.92	8.1	0.48	0.80	8.2	0.50
	Terminal {												
	Spur	1.26	9.1	0.67	1.16	8.3	0.57	0.76	8.2	0.47	0.88	8.6	0.50
	Long twig	1.26	9.3	0.67	1.04	7.5	0.63	0.60	8.3	0.46	0.80	8.6	0.47

the spur and long-twig classes. Only the wide differences are considered to be significant. These suggest that:—

1. Hexoses decrease very slightly during storage and there is no difference between the amounts present and their behaviour in the four classes of fruits.
2. Sucrose decreases markedly during storage. There is approximately 50 per cent. more at the beginning in the lateral groups than in the two terminal groups. The decrease during storage, however, is more rapid in the former group than in the latter, and at the time when the last sample was taken, the amount present was approximately equal in all groups. The behaviour of the sucrose suggests, as did the loss in total weight, that the division into lateral and terminal classes is a real one, much more so than the division into spur and long-twig classes.
3. Acid, which is expressed as malic, decreases during storage. There is probably no significant difference between any of the classes.

(b) *The Effect of Thinning on the Composition of Terminal and Lateral Fruits.*

The thinning experiment was carried out on six large standard trees about 25 years old, of the variety Bramley's Seedling, growing in a commercial plantation and all of which were cropping heavily. Thinning was carried out on July 29th, 1930. The choice of date was unavoidable and was later than was desired if the best results were to be obtained. Fruit was thinned to one per cluster and to eight or nine inches apart, lateral and terminal fruits being removed indiscriminately. Whilst the proportion of lateral to terminal fruits, both removed in thinning and obtained as a crop, varied from tree to tree, it was approximately one to one. The data relating to the crop will not be presented here; it is sufficient to say that thinning effected only a slight redistribution of the grades of the crop and that the terminal fruits were on the whole larger than the laterals.

Composite samples of 25 apples were taken for analysis, acids and sugars being estimated as before. The chief ash constituents were also determined. The average loss of total weight of 15 apples was also obtained during a period in cold storage at 1°C. The chemical history in storage is not available for this series, though a cold storage test to investigate keeping qualities was made. The keeping qualities appeared to be identical in all the groups, the amount of breakdown being only slight after a period of 238 days.

A summary of the more important data obtained is presented in Tables III, IV and V.

TABLE III.

Loss in weight in grs. per 100 grs. of apple after 7 months in storage at 1°C.

		Tree 7.	Tree 8.	Tree 6.	Tree 2.
Lateral	Thinned ..	—	6.4	—	5.9
	Not thinned	6.2	—	5.1	—
Terminal	Thinned ..	—	5.7	—	5.0
	Not thinned	4.9	—	—	—

TABLE IV.

Dry Weight, as per cent. Fresh Weight.						Acid, as per cent. (malic) in Fresh Weight.					
		Tree 1.	Tree 7.	Tree 8.	Tree 6.	Tree 2.	Tree 1.	Tree 7.	Tree 8.	Tree 6.	Tree 2.
Lateral	Thinned ..	11.1	—	11.55	—	12.1	0.78	—	0.83	—	0.78
	Not thinned ..	—	11.4	—	11.1	—	—	0.80	—	0.80	—
Terminal	Thinned ..	11.1	—	11.40	—	11.0	0.76	—	0.76	—	0.74
	Not thinned ..	—	11.25	—	—	—	—	0.80	—	—	—

TABLE V.

		Tree 1.		Tree 7.		Tree 8.		Tree 6.		Tree 2.	
		Sucrose.	Hexoses.	Sucrose.	Hexoses.	Sucrose.	Hexoses.	Sucrose.	Hexoses.	Sucrose.	Hexoses.
Lateral	Thinned ..	2.03	6.78	—	—	2.12	6.67	—	—	2.0	7.06
	Not thinned ..	—	—	1.83	6.80	—	—	1.97	6.41	—	—
Terminal	Thinned ..	2.09	6.80	—	—	2.01	6.85	—	—	2.02	7.12
	Not thinned ..	—	—	1.31	6.80	—	—	—	—	—	—

Tree 1 and Tree 7, Tree 8 and Tree 6, were paired at the time of thinning since they were similar in crop and growth features.

Loss of Total Weight.

At the low temperature, 1°C. and high humidity, 95 per cent. saturation, of the storage conditions, the loss in weight is very much less than was the case with the Allingtons. The data are not conclusive, but it may be that thinning is associated with greater loss of weight during storage.

As was the case with the Allington experiment, the laterals lost more weight than the terminals, though the difference is not so marked.

Proportion of Dry Matter.

The only regular difference is that between the lateral and terminal group, the laterals containing a greater proportion of dry matter from trees 7, 8 and 2. The differences, however, are very small.

Acid.

In the fruit from the three thinned trees, the lateral group contains more acid than the terminal. In the not thinned fruits

the amounts of acid are equal. The result from the not thinned group is therefore in agreement with the result from the Allingtons.

Sugars.

Hexoses show no consistent differences, being approximately at the same level in all cases.

Sucrose is at a higher level in the fruits in the thinned group than in the not thinned group. This is in agreement with other results obtained at Long Ashton (7).

In the not thinned group the lateral fruits contain nearly 50 per cent. more sucrose than do the terminal fruits, which is in agreement with the results from the Allington series.

The effect of thinning in addition to increasing the sucrose in the laterals slightly, has been to increase the sucrose in the terminals to the same level as that in the laterals.

The Ash Constituents.

There are no consistent differences in the ash constituents and the classes vary only slightly from one to the other. The complete results therefore are not presented. The following figures represent the limits between which the individual constituents varied within the whole experiment. They are expressed as percentages of the fresh weight.

Carbonate Ash ..	0.141 to 0.164	Calcium (CaO) ..	0.004 to 0.006
Potassium (K ₂ O) ..	0.071 to 0.083	Magnesium (MgO) ..	0.005 to 0.006
Sodium (Na ₂ O) ..	0.001 to 0.004	Phosphorus (P ₂ O ₅) ..	0.016 to 0.021

DISCUSSION.

Lateral fruits have a higher original concentration of sucrose, and lose it more rapidly than is the case with the terminals. It is in this same direction, amongst others, that later picked fruits differ from earlier picked fruits as was shown by Archbold. (See page 45 of this Report for a fuller discussion of the effects of time of picking on fruits.) This might suggest that the lateral fruits thus correspond to later picked fruits and therefore would be more mature. The rate of loss of total weight, however, is greater from the laterals than it is from the terminals, and this is opposed to the facts as reported for later picked fruits, the rate of loss of total weight being less in the latter case than it is in earlier picked samples.

The crop in the Allington series had not been controlled at all by systematic thinning, but records of the individual fruits were kept, and in some cases thinning to one fruit per cluster had taken

place naturally. Other details of fruit position were also noted, and compared with the character of the fruit. It has not been possible to establish a connection between the fairly considerable variation between individuals, and these detailed observations which were collected. Nevertheless, the impression was obtained that the differences between lateral and terminal fruits were not dependent upon such factors as had been considered, including the thinning of fruit to one per cluster. This was the case with all the characters which mark the two classes of fruits, including the content of sucrose. The effect of thinning of the Bramleys on the sucrose content, *i.e.* making it equal in both cases, is therefore not completely understood. The shape differences and differences in the rate of loss of total weight were not interfered with by the thinning in this case.

In further work which is in progress both the possibility of a maturity factor and the effect of thinning are being considered.

CONCLUSIONS.

1. When crop thinning was carried out lateral fruits of Allington Pippin and of Bramley's Seedling

- (a) contained 50 per cent. more sucrose at the normal picking date than did the corresponding terminal fruits ;
- (b) showed no significant difference in acid content from the terminal fruits, and
- (c) in the case of Allingtons lost both sucrose and total weight more rapidly in storage than did the terminal fruits.

2. Thinning to one fruit per cluster in an experiment with Bramleys produced

- (a) an increase in the concentration of sucrose in all fruits ;
- (b) an equalisation in sucrose concentration in laterals and terminal fruits ;
- (c) a slightly greater concentration of acid in lateral fruits than in terminals.

3. The rate of loss of total weight in storage was greater in all lateral fruits, thinned or not thinned, of Allington Pippin and Bramley's Seedling than in the terminals.

The ash constituents in the fruits in the Bramley's Seedling experiment were similar in amounts, and showed no consistent differences due to position in the cluster, or to thinning treatment.

REFERENCES.

- (1) CARNE, W. M., PITTMAN, H. A. and ELLIOT, H. G. "The Present Position of the Bitter Pit Problem in Australia." *Proc. 1st Imp. Hort. Conf.* 1930. *Part III*, p. 37.
- (2) CARNE, W. M. "A Preliminary Note on a Theory of Bitter Pit." *Journ. Dept. Agric. W. Australia*. 4. p. 382, 1927.
- (3) DETJEN, L. R. and GRAY, G. F. "Physiological Drop of Fruits." *Delaware Agric. Exp. Sta. Ann. Rpt.* 1928, p. 24. (*Bull.* 158.)
- (4) HEINICKE, A. J. "The Seed Content and the Position of the Fruit as Factors influencing Stippen in Apples." *Proc. Amer. Soc. Hort. Sci.* 1920. p. 225.
- (5) LANE, J. H. and EYNON, L. "Determination of Reducing Sugars by means of Fehling's Solution with Methylene Blue as Internal Indicator." *Journ. Soc. Chem. Ind.* Vol. 42, p. 32, 1923. Vol. 44, p. 150, 1925.
- (6) RANKER, E. "Some Physiological Considerations of the Delicious Apple with special reference to the problem of Alternate Bearing." *Amer. Journ. Bot.* 13. p. 406, 1926.
- (7) WALLACE, T. "Factors influencing the Storage Qualities of Fruits." *Proc. 1st Imp. Hort. Conf.* 1930. *Part III*, p. 9.
- (8) WHIPPLE, O. B. "Variation in Apples as determined by the Position of the Fruit in the Fruit Cluster." *Proc. Amer. Soc. Hort. Sci.* 1917. p. 71.

CARABID BEETLES AS STRAWBERRY PESTS IN THE CHEDDAR DISTRICTS.*

BY C. L. WALTON AND H. G. H. KEARNS.

INTRODUCTION.

From time to time there have been complaints of serious injury by Carabid Beetles to the ripening strawberry crop in the Cheddar district. In 1927, for example, these pests were troublesome, and some tentative inquiries were made in the late autumn of that year; and in 1928, further observations and some small field trials were carried out. Early in 1929, a detailed investigation was commenced and continued until the end of the season in 1930, and a brief summary of the results is given in this article.

Thanks are due to various strawberry growers for their co-operation and to the Colston Research Society for providing a grant towards the expenses of one of the investigators.

A definite attempt was made (1) to determine the species of beetles actually responsible for the injuries, and the type and degree of such damage, (2) to investigate the life histories of such species as proved to be harmful, and (3) to discover means of prevention or control.

Injuries occurred during the season of 1928, but they were more limited and sporadic in character than in 1927; they became slight in 1929 and were almost absent during 1930. As a result, therefore, although the data required under the above headings (1) and (2) were secured to a large extent, progress with control work was greatly hampered and extensive series of trials were abortive, more especially during 1930. The probable reasons for this will be explained below.

The principal type of injury consists of the cracking and removal of the seeds of the berries when they are ripe or nearly so. This injury spoils the appearance of the fruit, rendering it unsaleable, the berry becoming soft and discoloured and finally shrivelling. On occasion green fruit is also attacked, proper development being prevented. Other forms of damage also occur and are described below.

* Reprinted from the Journal of the Ministry of Agriculture, July 1931, by kind permission of the Controller of H.M. Stationery Office.

Distribution and Amount of Injury.

The main type of injury has long been known and described, and was correctly attributed to Carabid Beetles, both in this country and on the Continent. Although these beetles are abundant everywhere, serious injuries are only reported from certain districts. During the period of this investigation, severe damage was recorded in the Eastern counties; a few serious outbreaks occurred in Kent, and limited outbreaks were reported from Hants and Devon. The amount of damaged fruit may reach 70 per cent. of the crop, whilst injuries of 50 and 60 per cent. are frequently reported. In the Cheddar district, the damage appears to be specially severe in rows of strawberry plants near hedgerows and headlands. If picking time of the earliest fruit coincides with the optimum climatic conditions for the Carabid Beetles, the financial loss becomes considerable. A marked feature of these attacks is their discontinuity and sporadic distribution. The beds affected in one year may be free from attack during the following season, whilst a neighbouring bed—hitherto free—may be ravaged; one part of a bed may be attacked this season, and another part next year. At first sight these peculiarities appear most puzzling:

The Beetles Causing the Injuries.

The beetles causing these injuries belong to the family *Carabidae*, often known as "Ground Beetles." The members of this family are numerous and widely distributed, occurring in soil, under stones, moss, bark, etc. They are active, generally dark or metallic in colour, and as a rule are carnivorous in habit, although certain species (including some of those now under discussion) have been recorded as damaging plants, including beet and cereals. The larval stages are likewise active and predaceous. Numerous species occur on strawberry beds and, in the course of the observations in the Cheddar district, some thirty were obtained from the trap pots utilized. Many of these had clearly nothing to do with the injuries and others were scarce. Six very abundant species, however, were suspected or had previously been implicated more or less surely, and these were selected for observation and investigation.* The chief culprit is the species scientifically known as

* The following are the scientific names of the six species referred to:—(1) *Ophonus pubescens* Ml. (*Harpalus ruficornis* F.); (2) *Abax ater* Vill. (*striola* F.); (3) *Pterostichus madidus* F.; (4) *Pterostichus vulgaris* L.; (5) *Pterostichus cupreus* L.; (6) *Nebria brevicollis* F. The first four are shown in Figs. 1 to 4, respectively; the last two, although sometimes present on the beds in large numbers, have not been found to be injurious. *Abax ater* has only once caused injury in the writers' experience (under controlled conditions). It is a large insect, $\frac{5}{8}$ to $\frac{3}{4}$ in. in length, of a uniform shiny black; it can be distinguished by the quadrangular thorax, which has sharp angles.

Ophonus pubescens (*Harpalus ruficornis*) and, as far as can be ascertained, it is responsible in the main for the injuries complained of. This insect, which it is proposed to call the Strawberry Seed Beetle, is $\frac{1}{2}$ to $\frac{5}{8}$ in. in length and may be recognized by the greyish-golden hairs with which the wing-covers (elytra) are covered, and by the red-brown legs (Fig. 1). Two other species (*Pterostichus madidus* and *P. vulgaris*) may also cause quite serious damage of a different kind by attacking the flesh of the berries, in which they eat holes, often of considerable size and much resembling the work of slugs and certain birds. Both are shining black beetles, about $\frac{1}{2}$ to $\frac{5}{8}$ in. in length, very similar in general appearance (Figs. 2 and 4, respectively). There is no evidence that they attack the seeds or cause blemishes similar to those due to the activities of the Strawberry Seed Beetle.

The types of injury are shown in Figs. 5 to 8. These were obtained by potting up strawberry plants bearing ripening fruits in cages in the insectary at Long Ashton during each season. Injuries were readily produced by beetles introduced into the cages from the affected fields.

This account of the kind of damage done and of the beetles concerned refers to the Cheddar district, and it is possible that other species may be associated with injuries to fruits in other districts.

Life Histories and Habits of the Beetles.

The life histories of the species described have been investigated during the course of this work and the main features have been elucidated. Considerable trouble was encountered in regard to the Strawberry Seed Beetle, which proved difficult to rear under laboratory conditions, and its life cycle differs somewhat in time from that of the three others. In general, there is considerable agreement in respect of habits, food and reaction to varying environments.

The injurious species are mainly nocturnal in habit and prefer to hide in the soil, amongst weeds, under stones, etc., by day, particularly during bright weather. Further, they dislike drought conditions and bury or hide themselves during such periods. They appear to be most active on the surface during warm, damp periods, and the greatest amount of injury seems to occur then. Thus, it appears that when dry weather (and dry surface soil) is followed by a reasonable amount of rain during the fruit-picking period, an attack is likely to result. The ripening period in Cheddar usually extends from the end of May to early July. A comparison of

weather records with the history of beetle damage during the past four years strongly supports the above observations. The ripening periods of 1927-30 have shown decreasing rainfall and the amounts of crop injury have been correspondingly reduced.

The female beetles lay eggs in batches of 10 to 15 on the surface of damp soil or within burrows they have made, the eggs of the Strawberry Seed Beetle being the largest and least numerous. Adults are most abundant from June to October. The larvae are elongate in form, are very active and generally feed on various small creatures in the soil as long as suitable weather and soil conditions allow. It has, however, been found that a mixed animal and vegetable diet is often preferred, and this is particularly so with the Strawberry Seed Beetle. They pass through three stages (or instars) during their life history and are very intolerant of dry conditions. Most are in their third stage by January, though the Strawberry Seed Beetle does not reach this stage until a good deal later.

Numbers of adults overwinter, either deep in the soil (more particularly in worm holes and in the vicinity of plant roots) or in banks, hedges or turf heaps. It does not seem (about Cheddar) that many pass the winter in the soil beneath the fields, the majority going to the banks surrounding the small fields so typical of the district. They avoid decomposing sodden rubbish such as is frequented by woodlice. In spring, the hibernated and newly emerged adults again become active, and mating and egg-laying proceed.

Control Measures.

Trapping.—The usual method employed against these pests is that of "trapping." This is frequently performed in a haphazard and perfunctory way, and consists in putting down in the beds a number of jars of various sorts and sizes into which beetles of all kinds fall at hazard. In some cases "baits" of liver or other offals may be added. It is obvious that great numbers may be caught by this means, but there seems little evidence that it is effective in reducing the beetles sufficiently to prevent or minimise the damage done.

With the object of obtaining definite evidence, three plots—all having a history of previous damage—of 1/10th acre each, were selected in 1930, and 45 two-pound jars per plot were set in the earth at regular intervals, with "control" (untreated) plots alongside and between them.

The total catches were removed at fairly regular intervals between March and November, the beetles being identified, counted and tabulated. Interesting data were thus obtained as to sequence,

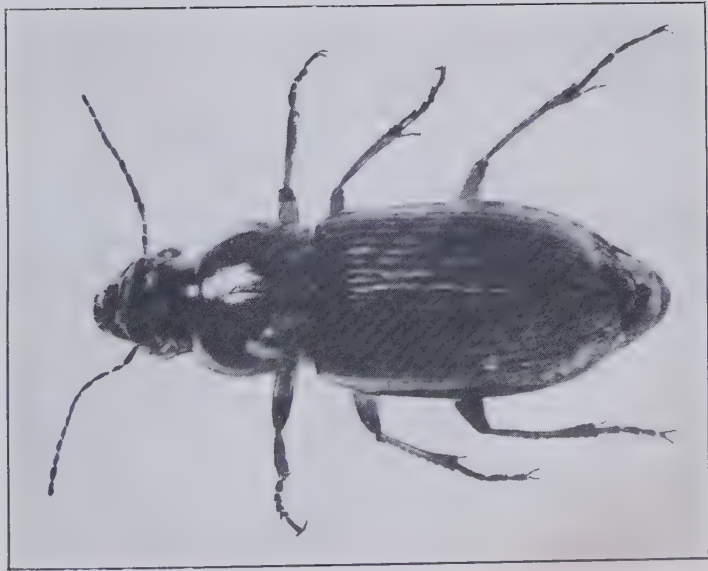


FIG. 1.—The Strawberry Seed Beetle (*Ophonus pubescens*).

CARABID BEETLES AS STRAWBERRY PESTS.

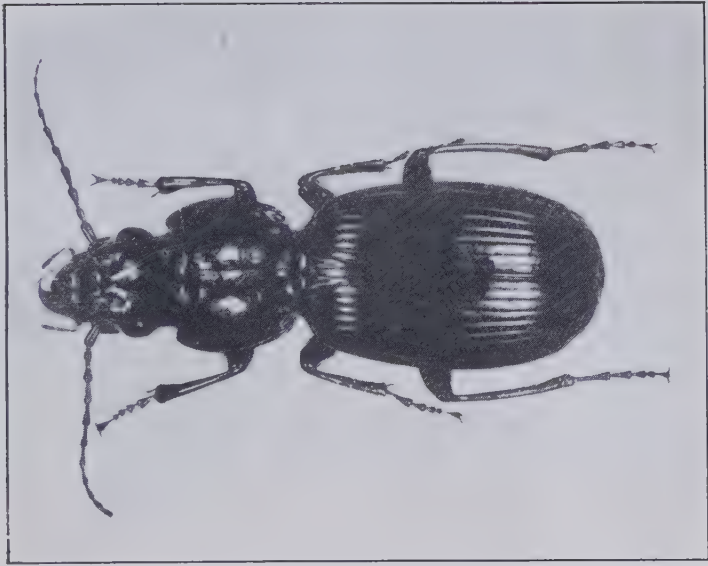


FIG. 2.—*Pterostichus madidus*.

By kind permission of Controller H. M. Stationery Office.

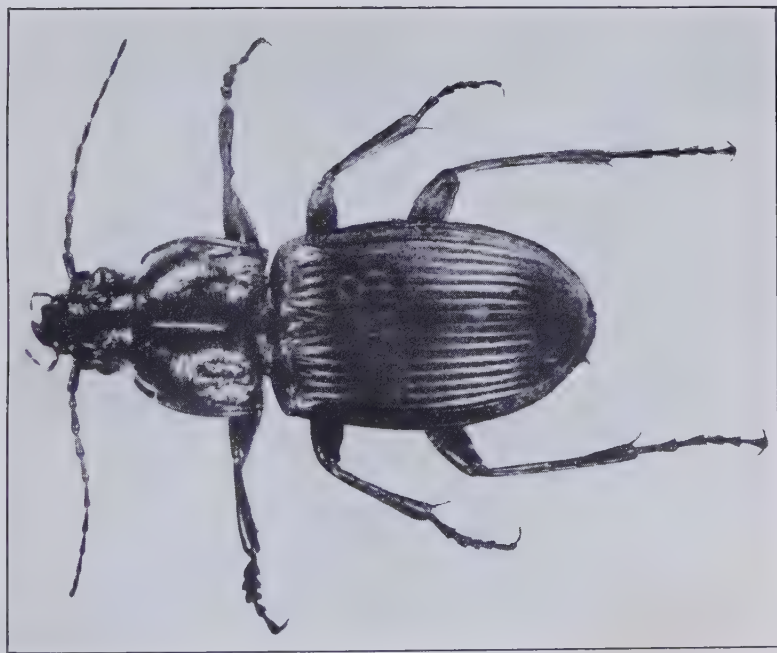


FIG. 3.—*Abax ater (striola)*.

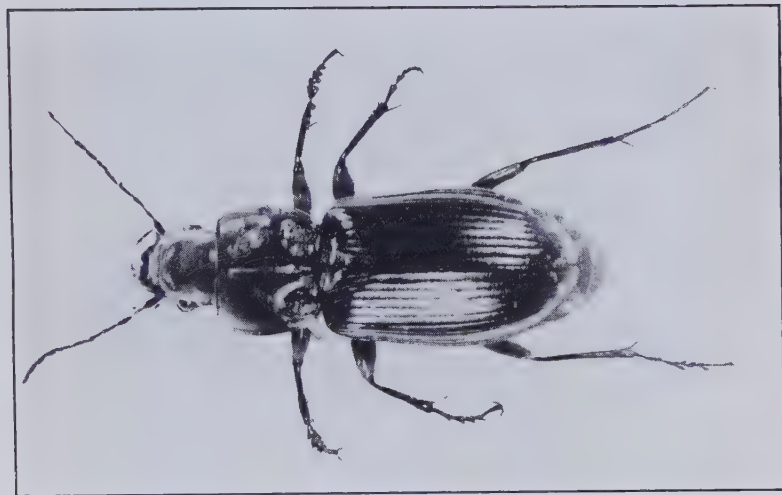


FIG. 4.—*Pterostichus vulgaris*.



FIG. 5.—Undamaged fruit.

FIG. 6.—Damaged by the Strawberry Seed Beetle (*O. pubescens*).

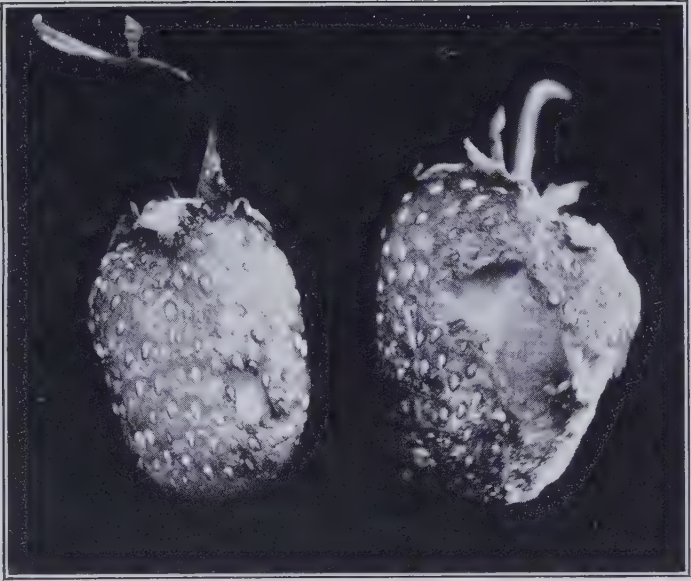


FIG. 7.—Slightly damaged by *Abax ater*.

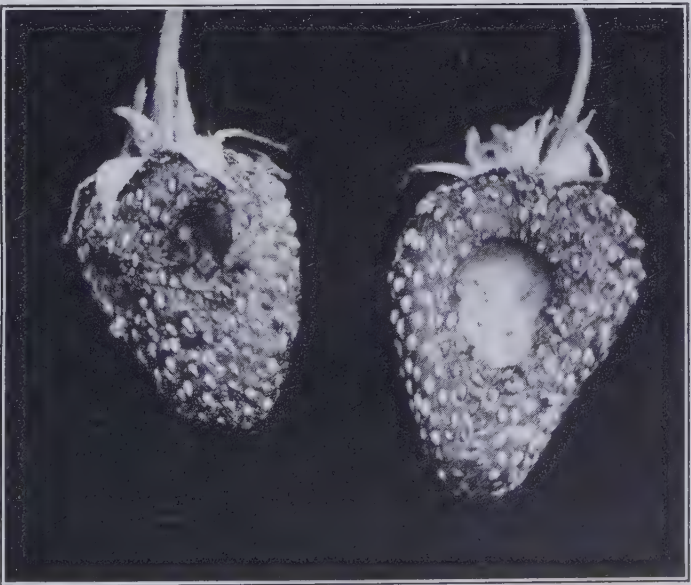
FIG. 8.—Severely damaged by *Abax ater*.

CARABID BEETLES AS STRAWBERRY PESTS.

By kind permission of Controller H.M. Stationery Office.



FIGS. 9 and 10.—Damage by *P. madidus*.



FIGS. 11 and 12.—Damage by *P. vulgaris*.

CARABID BEETLES AS STRAWBERRY PESTS.

By kind permission of Controller H.M. Stationery Office.

relative abundance, etc., of the harmful (and other) species, but the main object was not attained, since no attack developed on either the "trapped" or "control" plots. Further experiments are needed to determine whether trapping provides a reasonable method of control.

Dressings.—*Naphthalene* (in various forms) has been used to a considerable extent, generally broadcast amongst the ripening crop. Several growers have claimed that this deterrent has had the desired effect in preventing attack, and an endeavour was made during 1929 and 1930 to investigate these statements. Here again no definite evidence was obtainable owing to the non-appearance of injuries on either treated or untreated plots. Further, on most of the plots where the growers claimed success, the dressings were applied coincidentally with the onset of dry conditions.

Sodium Fluosilicate.—Small plots were dressed with this dust after attacks had commenced in 1928, and injuries ceased on these areas although continuing on the untreated portions. Unfortunately, the dust injured the ripening fruits. Further experimental dressings in subsequent years, put on before the ripening of the crop, were vitiated (as in other experiments) by absence of attacks, but no apparent damage was done to flowers, immature fruit, runners or foliage, which were heavily dusted during the dry conditions of 1930.

Pyrethrum.—Sprays of varying strengths applied to badly attacked plots in 1928 showed no reduction in injury. Neither fruit nor foliage was damaged by the spray.

Preventive Methods of Control.

It seems clear that definitely hopeful results are obtainable by preventive measures, and attention is drawn to the following points which have been noted during the course of the investigations:—

- (1) Removal of shelter in which beetles can either overwinter, or find harbourage during the daytime, or during drought in the vicinity of the strawberry beds. This includes—
 - (a) banks of earth from which beetles certainly emerge in spring: (b) heaps of earth or sods, which provide shelter for great numbers of beetles by day and during dry weather. (In one particular case, injuries were severe on either side of a long mound of sods, and the presence of the Strawberry Seed Beetle within it was proved; on removal of the mound, the injuries ceased. Damage is frequently most serious on headlands and near banks and hedges): (c) weeds, which are sometimes allowed to accumulate as the crop ripens, undoubtedly conserve moisture and provide shelter by day, as do rough headlands and field corners.

- (2) Clean cultivation not only ensures the absence of sheltering weeds, but a fine tilth maintains a layer of soil too dry for beetle larvae to live in, and unsuitable in moisture content for the adult insects. It is believed that differences in moisture content probably play a considerable part in bringing about concentrations of beetles on certain fields or parts of fields.
- (3) Observation suggests that a judicious use of poultry can do much to keep down the beetle population, particularly on the headlands, and can, in some instances, be utilized as a barrier to incoming beetles from rough land, banks, etc., although it must be remembered that the Strawberry Seed Beetle is able to fly.

SUMMARY.

Four species of Ground Beetles have been proved to be the cause of injuries to ripening strawberries at Cheddar and elsewhere. One species—*Ophonus pubescens* (here called the Strawberry Seed Beetle)—is responsible for the worst type of damage, namely, the removal and ingestion of the seed contents, thereby ruining the fruit. The other species either cause less marked injuries, or gnaw holes in the fruit.

These various types of damage have been produced under controlled conditions, and are figured in this article. The life histories of these beetles have been worked out. Overwintering of both larvae and adults is shown to take place, to a considerable extent, chiefly in hedges and banks.

Dry conditions appear to be inimical to the beetles in both the larval and adult conditions.

Attempts to test out the value of trapping as a means of reducing beetle populations and of naphthalene as a deterrent were both vitiated by absence of injuries, largely due to drought conditions.

Injury can probably be minimised by the removal of shelter, by clean cultivation and the judicious use of poultry.

THE CONTROL OF CAPSID BUGS ON BLACK CURRANTS.

FIELD EXPERIMENTS IN 1931.

BY L. N. STANILAND AND C. L. WALTON.

An account of field trials on the control of capsid bugs on black currants conducted during 1930 appeared in the Journal of the Ministry of Agriculture in August of that year, and detailed the successful use of a winter wash prepared from a mixture of high boiling tar oil and a heavy paraffin, used at a concentration of 10%.

These trials, which were carried out at two centres, showed a practically complete control of Capsid Bugs, but could only be regarded as of a preliminary character to be followed by further and more extended trials. The latter were arranged and carried out during the following year, and the present paper deals with them.

During previous years, a series of field trials had shown an ever-increasing degree of control. In those of 1928-29, the use of the improved type of tar-distillate wash at 10% concentration resulted in a 70% infestation being reduced to one of 20%, whilst, as described in the account of the previous year's trials, in 1929-30, a tar oil-heavy paraffin wash at the same strength reduced infestations of 100% of bushes and 30% and 60% of leaves respectively to a "trace." The 1931 programme was designed to furnish a more complete and comprehensive trial of the latter wash and to provide evidence as to the relative toxicities and required concentrations of the respective constituents. It also included trials of certain cheaper oils with a view of reducing the cost of spraying.

The work was carried out as heretofore with the aid of a special research grant from the Ministry of Agriculture and Fisheries.

Thanks are due to Dr. H. G. H. Kearns (the present Advisory Officer) for his help in gathering some of the data in the absence of one of the writers (C.L.W.).

*Materials.**

(1) A neutral tar-distillate (boiling between 280° and 360°F.) obtained from a horizontal retort tar.

(2) Heavy paraffins, having the following characteristics :—

	Specific Gravity. (60°F.)	Viscosity. Redwood No. 1 at 76°F.	Iodine Value.	Flash Point (open).
(a) A "White Oil" No. 105 (P2)	0.860	125	1.1	310°F.
(b) A "Half White Oil" (No. 1301) cheaper oil	0.875	160	7.6	310°F.

(3) A blast furnace oil.

The last named is not at present a recognised commercial product. The fraction was collected between 280° and 360°F., and was stated to contain 7% of tar acids.

All the washes were made and used in the form of "two solution" washes, *i.e.* the requisite amount of caustic soda solution for the completion of emulsification was added during the course of mixing.

The emulsifier employed was Agral W.B.

The washes were all made up from the raw materials at Long Ashton Research Station under the supervision of the Biochemist, Mr. F. Tutin.

Trial Centres.

The trials were conducted at the following two centres, particulars of which are appended.

CENTRE I.—County Experimental Station, Perdiswell, Worcester.

This centre was also used in the 1930 trials and was included for demonstration as well as trial purposes. The same set of bushes served for the trials and the presence of the control bushes left the previous year ensured a heavy reinfestation of the whole, rendering them suitable for further experimentation.

The following varieties of black currants were included in the plot :—Goliath, French, Baldwin, Seabrook's Black and Edina.

The total number of bushes in the trial was 208.

Both species of Capsid Bug (*P. rugicollis* and *L. pabulinus*) were present.

* We are indebted to Messrs. Shell Mex Ltd. for kindly supplying the heavy paraffin oils, and to the Pearson Antiseptic Co. Ltd., for the Blast Furnace Oil.

CENTRE II.—Spring Hill, Fladbury, Worcestershire.

Variety: Baldwin.

The total number of bushes in the trial was 1,370.

Treatments and Results.

CENTRE I.—The treatments carried out were:—

Plot 1. Tar oil-heavy paraffin wash (two-solution) in equal proportions at 10% strength. The form of heavy paraffin used was P2 (white oil), the same as in 1930. Eighty bushes were utilised (50 were sprayed on 13th January, 1931, and 30 on 22nd January, 1931).

Plot 2. Unsprayed. 124 bushes sprayed with a 5% solution of a proprietary tar-distillate wash on 22nd January, 1931, for Aphis control.

The applications were made during fine, dry weather.

The spray was applied by means of a “headland” pump at a pressure of 100 lbs. per square inch.

The results were examined on July 2nd, 1931, and proved to be as follows:—

Plot 1. Control had been complete, but by the date of examination, slight secondary attacks were just commencing on a few tip leaves, on bushes adjacent to the control plot and a boundary hedge. These had unquestionably served as sources of infection.

Plot 2. All bushes attacked and an average of 40% of leaves were affected.

The clear-cut difference between the two plots was so marked and decisive that no detailed comment of the results is required. The spray fluid used had obviously achieved the object of complete destruction of the capsid eggs on the sprayed bushes, as in the previous year's trial at this centre.

CENTRE II.—The treatments carried out were:—

<i>Plot.</i>	<i>No. of bushes.</i>
1. High boiling neutral tar-oil at 10% strength	120
2. Blast furnace oil at 10% strength	80
3. Heavy paraffin oil (half white) at 5% strength	190
4. Unsprayed I.	80
5. Heavy paraffin oil (white) at 5% strength	90
6. Neutral tar oil-heavy paraffin (white), mixed in equal proportions, at 10% strength	160
7. Neutral tar oil-heavy paraffin (half white), mixed in equal proportions, at 10% strength	180
8. Neutral tar oil-heavy paraffin (white), mixed in proportions 25 tar oil, 75 paraffin, at 10% strength	140
9. Neutral tar oil-heavy paraffin (white), mixed in equal proportions, at 6% strength	90
10. Neutral tar oil-heavy paraffin (half white), mixed in equal proportions, at 6% strength	90
11. Neutral tar oil-heavy paraffin (white), mixed in proportions 25 tar oil, 75 paraffin, at 6% strength	70
12. Unsprayed II.	80
Total	1370

The applications were made on February 11th and 12th, 1931, by means of a power sprayer working at 200 lbs. pressure. On the former date, there was a strong breeze and weather was dry up to 1 p.m., when rain suddenly stopped work for the day. By that time Plots 1—5 had been sprayed. On the 12th, there was a strong breeze but the weather was fine and sunny and the remaining plots were sprayed without interference.

The figures are estimated percentages of leaves marked by capsid bugs. These were arrived at by eye estimations* on the part of the authors acting independently. Differences of opinion—these were very few and of minor importance only—were adjusted by a final conjoint examination.

The results were examined on two occasions, May 19th and July 1st respectively. The details are given in the appended table :—

Plot.	Treatment.	Percentage of leaves marked by Capsid Bugs.	
		Examination of May 19th.	Examination of July 1st.
1.	Tar oil at 10% strength	5—10	70
2.	Blast furnace oil at 10% strength ..	10—15	60
3.	Half white oil at 5% strength	Trace	5—10
4.	Unsprayed I.	20—30	60—70
5.	White oil at 5% strength	1—2	10
6.	Tar oil + white oil (50—50 mixture) at 10% strength	Trace	Trace—2
7.	Tar oil + half white oil (50—50 mixture at 10% strength	Trace	2—5
8.	Tar oil + white oil (25—75 mixture) at 10% strength	2—3	5—10
9.	Tar oil + white oil (50—50 mixture) at 6% strength	5—10	25—30
10.	Tar oil + half white oil (50—50 mixture) at 6% strength	5—10	50
11.	Tar oil + white oil (25—75 mixture) at 6% strength	15—20	30—40
12.	Unsprayed II.	60—70	90

Aphids were present in small numbers, but it is interesting to note that they were found only on the unsprayed blocks and on those plots sprayed with the respective heavy paraffin oils, used by themselves. All other washes used gave complete control of this pest.

No damage to buds or foliage, by the sprays used, was noted during the progress of the experiments.

* The method of eye estimation has been tested by the authors in previous trials and the results compared with those of actual counts. A high degree of accuracy is possible when used by a trained observer.

The following features of the results may be noted :—

1. The wash consisting of neutral tar oil, used by itself at 10% strength, although giving some control of Capsid Bugs, was not sufficiently effective for commercial use.

2. The blast furnace oil gave only slightly better results than the neutral tar-oil.

3. The white and half white oils used by themselves at 5% strength gave satisfactory reductions in the amount of Capsid Bug damage, and there was close agreement in the results obtained with each of them.

4. The tar oil-heavy paraffin mixtures, used in equal proportions, at 10% strength, gave excellent controls of Capsid Bugs; when used at 6% strength the results were not of a satisfactory character.

5. The tar oil-heavy paraffin mixtures, used in the proportions of 25 parts of tar oil to 75 parts of the heavy paraffin and at strengths of 10%, were not so satisfactory as the 50—50 mixtures. At 6% strength, these 25—75 mixtures were far from satisfactory.

Since the general trend of the results of the trial as a whole indicates the heavy paraffin constituent of the spray to be the main toxic agent in the case of the Capsid eggs, the apparent falling off in toxic power on increasing the percentage of this constituent from 50 to 75 is unexpected. No explanation will be attempted here, further investigation being required to determine if the result is confirmed or shown to be a chance one to which field trials of this description are necessarily subject.

6. The figures for Plots 1—5 suggest that the rain which followed so closely after spraying in these cases had relatively little, if any, detrimental effect on the results. This is contrary to general experience with ordinary tar oil sprays.

7. The paraffin oils used alone at 5% strength, while giving satisfactory control of capsid bugs, do not control aphids. This should be specially noted by growers.

CONCLUSIONS.

1. The experiments described confirm decisively the results of 1929-30, and indicate that mixtures of equal proportions of tar oil and heavy paraffin oil, made up at 10% strength, gave a practically complete control of Capsid Bug on black currants.

2. Although the paraffin oils used alone at 5% strength were effective in giving satisfactory control of Capsid Bugs, it was necessary to use the tar oil-heavy paraffin mixture where aphid control was also desired.

3. Price considerations may usefully be taken into account in determining the type of heavy paraffin oil employed, the cheaper half-white oil having proved as effective as the more expensive white oil.

FIELD TRIALS OF TAR DISTILLATE— HEAVY PARAFFIN WASHES FOR APPLE CAPSID BUG (*P. RUGICOLLIS*) CONTROL.

(SEASON 1930 - 31).

BY L. N. STANILAND AND C. L. WALTON.

INTRODUCTION.

In consequence of the successful preliminary results obtained with a tar distillate-heavy paraffin wash as a means of control of Capsid Bugs on Black Currants (1) it was decided during the spraying season of 1930-31 to extend the testing of this type of wash to the case of the Apple Capsid Bug.

The trials were designed to test the efficacy of the "High Neutral" tar distillate wash combined with two different types of paraffin (one considerably cheaper than the other) and to contrast these with the High Neutral type of wash previously employed. All the sprays used were of the "two-solution" type.

The mineral oils utilised in these trials were as follows :—

	Specific Gravity (60° F.)	Viscosity Redwood No. 1 at 70° F.	Iodine Value.	Flash Point (open).
(1) A heavy paraffin "White" oil No. 105 (P2)	0.860	125	1.1	310° F.
(2) A heavy paraffin "Half "White" oil No. 1301 ..	0.875	160	7.6	310° F.

The trials were hampered by very adverse spraying conditions. loss of crop through the unfavourable weather at time of flowering. and severe attacks of Apple Sawfly at several centres where there was fruit.

(1) Staniland, L. N., and Walton, C. L., Journ. Min. Agric., August 1930, pp. 476-480.

Thanks are due to Messrs. Shell Mex Ltd. for supplying the oils used and to Dr. H. G. H. Kearns for help in collecting data during the illness of one of the authors.

The work was carried out with the aid of a Special Research Grant from the Ministry of Agriculture and Fisheries.

CENTRES AND TREATMENTS.

Centre I. Birlingham, Worcs.

No unsprayed "controls" were left at this centre, since, as in the 1929-30 trials at the same place, (2) it was used to illustrate the degree of progressive reduction of a severe capsid infestation which could be secured by means of successive sprayings.

Two separate blocks of trees, A and B, were treated.

A. A block of 324 trees employed in the season 1929-30 (2) :—

Varieties—Worcester Pearmain, Cox's Orange Pippin, Bramley's Seedling and James Grieve. All the trees were large half standards.

Treatments—(a) "High Neutral" tar distillate wash (two-solution) at 10% strength.

(b) A tar distillate-heavy paraffin (white) wash in equal proportions at 10% strength.

(c) A tar distillate-heavy paraffin (half white) wash in equal proportions at 10% strength.

Sprays were applied by means of a "Headland" sprayer at a pressure of 120 lbs. per square inch.

Dates of Application and Weather—February 24th—27th, 1931.

The weather was fine and calm on the 24th and 25th; wet on the 26th (no spraying being possible); and calm and overcast on the 27th, with some rain after completion.

B. A block of 131 trees which in the winter of 1928-29 had been sprayed with a proprietary tar distillate wash at 10% strength, and had also received one nicotine wash in the following spring at the "pink" stage. It was divided into three approximately equal sections which received the same three spray treatments as block 1.

Varieties—Worcester Pearmain and Bramley's Seedling.

Treatments—As for block 1.

(2) Staniland, L. N., and Walton, C. L. Ann. Rept. Agric. & Hort. Res. Stn., Long Ashton, Bristol, 1930, pp. 79-94.

Dates of Application and Weather—February 3rd and 4th, 1931.
The weather was fine but dull.

Centre II. Pinvin, Worcs.

Number of trees 47, all large half standards.

Variety—Worcester Pearmain.

Treatments—(a) A tar distillate-heavy paraffin (white) wash, mixed in equal proportions at 10% strength.

(b) Unsprayed blocks.

Sprays were applied by means of a "Headland" sprayer at a pressure of 120 lbs. per square inch.

Dates of Application and Weather—January 14th and 15th, 1931. The weather on January 14th was dry and sunny after a sharp morning frost. Later a north wind sprang up and the wash commenced to freeze on the trees on the north side. Spraying was abandoned at 12.45 p.m. and completed by the owners on the 15th.

Centre III. Ledbury (A) Herefordshire.

Number of trees 70.

Variety—Allington Pippin: large standard trees, interplanted with Newton Wonder and some plums.

Treatments—(a) A "neutral" tar distillate-heavy paraffin (white) wash mixed in equal proportions at 10% strength.

(b) Unsprayed blocks.

Sprays were applied by means of a power sprayer working at a pressure of 150—200 lbs. per square inch.

Date of Application and Weather—February 13th, 1931. The weather was sunny, and the trees dry: there was a slight breeze.

Centre IV. Ledbury (B), Herefordshire.

Number of trees 10.

Variety—Lord Derby: large standard trees.

Treatments—(a) Neutral tar distillate-heavy paraffin (half white) wash, mixed in equal proportions at 10% strength.

(b) Unsprayed block.

Spray was applied by means of a power sprayer at a pressure of 250 lbs. per square inch.

Date of Application and Weather—February 5th, 1931.
Weather fine and dry. Light breeze.

Centre V. Marston Magna, Somerset.

Number of trees 74.

Varieties—Worcester Pearmain, Cox's Orange Pippin, King of the Pippins and Bramley's Seedling. Bush trees of fair size.

Treatments—(a) Neutral tar distillate-heavy paraffin (white) wash, mixed in equal proportions, at 10% strength.

(b) Neutral tar distillate-heavy paraffin (half white) mixed in equal proportions at 10% strength.

(c) Unsprayed blocks.

Sprays were applied by means of a barrel type sprayer at a pressure of 200 lbs. to the square inch.

Date of Application and Weather—February 2nd, 1931. Weather fine and sunny. No wind.

Centre VI. Wilmington, Kent.

Number of trees 120. This plot was employed in the 1929-30 experiments (2).

Varieties—Lord Derby, Grenadier, Bismarck and Cox's Orange Pippin. Large half-standard trees.

Treatments—(a) Neutral tar distillate-heavy paraffin (white) wash, mixed in equal proportions at 10% strength.

(b)

Spray was applied by means of a power sprayer at a pressure of 100-150 lbs. per square inch.

Date of Application and Weather—February 20th, 1931. Weather dull and cold ; fairly strong S.W. wind.

RESULTS.

CENTRE I.—LEAF AND YOUNG FRUIT COUNTS.
*Percentages of leaves and young fruits marked during Spring of 1931.

Nature of Counts made and Date.	Variety.	Sprays applied early in 1931* (February 3rd and 4th). BLOCK I.				Sprays applied later in 1931* (February 24th to 27th). BLOCK II.		
		Tar oil at 10% strength.	Tar oil- paraffin (white) at 10% strength.	Tar oil- paraffin (half-white) at 10% strength.		Tar oil at 10% strength.	Tar oil- paraffin (white) at 10% strength.	Tar oil- paraffin (half-white) at 10% strength.
*Truss Leaf Counts (May 19th)	Worcester Pearmain ..	1.2	1.2	3.4		0.4	0.6	1.2
	Cox's Orange Pippin ..	—	—	—		0.3	0.2	0.2
	Bramley's Seedling ..	1.4	1.0	1.8		1.5	0.7	0.5
	James Grieve ..	—	—	—		15.5	0.3	0.6
*Young Fruit Counts (June 30th)	Worcester Pearmain ..	8.3	2.9	4.7		5.7	2.5	1.9
	Cox's Orange Pippin ..	—	—	—		3.9	0.5	0.3
	Bramley's Seedling ..	29.4	17.9	18.8		8.0	6.7	1.2
	James Grieve ..	—	—	—		5.6	1.9	0.5

* All counts made were of 1000 trusses and young fruits respectively, random samples being taken.

PERCENTAGE OF MATURE FRUIT MARKED BY CAPSID BUG.

Variety.	SEASON 1929.		SEASON 1930.		SEASON 1931.				Date of Counting.	
	Sprayed with old type tar-distillate washes (10% strength). (Block II)	Sprayed with "high neutral" (two-solution) tar distillate wash (10% strength). (Block II)	Sprayed with a "one-solution" high neutral tar distillate wash at 10% strength. (Block I)	Sprayed with "high neutral" tar distillate wash (10% strength).	Sprayed Feb. 3rd and 4th (Block I)	Sprayed Feb. 24th —27th (Block II)	Sprayed Feb. 3rd and 4th (Block I)	Sprayed Feb. 24th —27th (Block II)		
Worcester Pearmain	63.0	32.8	84.2	35.8 (1519)	13.5 (1282)	8.8 (1716)	8.1 (1286)	11.0 (1367)	8.9 (1437)	Sept. 16th & 17th, 1931
Cox's Orange Pippin	58.0	24.5	—	—	10.0 (1500)	—	2.3 (1588)	—	2.8 (1416)	Sept. 23rd 1931
Bramley's Seedling	32.0	29.5	62.7	52.1 (1175)	30.6 (1495)	42.0 (1659)	24.0 (1413)	72.7 (1743)	1.4 (1461)	Sept. 24th 1931
James Grieve	72.0	43.8	—	—	8.7 (308)	—	14.3 (799)	—	1.9 (258)	Sept. 16th 1931

CENTRE II.

Variety.	Treatment.	Percentage of Trusses marked by Capsid Bug. (Examined May 19th, 1931).	Percentage of young fruits marked by Capsid Bug. (Examined July 1st, 1931).
Worcester Pearmain ..	Unsprayed	63.6 (1000)	99.9 (58)
	Tar distillate- heavy paraffin (white) wash at 10% strength	1.9 (2000)	9.2 (437)

The crop of fruit was light and this accounted for the small number of fruits examined. Insufficient fruit remained on the trees to make a count of the mature apples significant. Although the spray froze on the trees and subsequently thawed and dried again, it gave a good control.

CENTRE III.

Variety.	Treatment.	Percentage of Trusses marked by Capsid Bug. (Examined May 21st 1931).	Percentage of young fruits marked by Capsid Bug. (Examined July 2nd 1931).	Percentage of mature fruits marked by Capsid Bug. (Examined Sept. 16th 1931).
Hillington Pippin ..	Unsprayed ..	35.8 (1000)	100.0 (2)	100.0 (1)
	Tar distillate- heavy paraffin (white) wash at 10% strength..	0.1 (1000)	4.5 (1000)	7.4 (1069)
	Tar distillate- heavy paraffin (half-white) wash at 10% strength ..	0.6 (1000)	9.0 (1000)	13.3 (1338)

CENTRE IV.

Variety.	Treatment.	Percentage of Trusses marked by Capsid Bug. (Examined May 21st, 1931).	Percentage of young fruits marked by Capsid Bug. (Examined July 2nd, 1931).
Lord Derby	Unsprayed	22.0 (1000)	30.9 (197)
	Tar distillate-heavy paraffin (half-white) wash at 10% strength	1.1 (1000)	14.2 (254)

There was insufficient fruit at this centre for counts of mature apples to be significant.

CENTRE V.

Variety.	Treatment.	Percentage of Trusses marked Capsid Bug. (Examined May 18th, 1931).	Percentage of young fruits marked by Capsid Bug. (Examined June 29th, 1931).
Worcester Pearmain ..	Unsprayed	27.0 (500)	67.6 (300)
Cox's Orange Pippin ..	"	52.6 (500)	No fruit.
Bramley's Seedling ..	"	41.6 (500)	Insufficient fruit.
King of the Pippins ..	"	51.4 (500)	No fruit.
Worcester Pearmain ..	Tar distillate-heavy paraffin (white) wash at 10% strength	5.2 (500)	9.8 (502)
Cox's Orange Pippin ..	"	2.8 (500)	19.2 (438)
Bramley's Seedling ..	"	5.4 (500)	Insufficient fruit.
King of the Pippins ..	"	2.1 (500)	8.6 (500)
Worcester Pearmain ..	Tar distillate-heavy paraffin (half-white) wash at 10% strength	2.6 (500)	4.2 (562)
Cox's Orange Pippin ..	"	5.2 (500)	14.6 (500)
Bramley's Seedling ..	"	5.0 (500)	Insufficient fruit.
King of the Pippins ..	"	1.2 (500)	27.0 (500)

CENTRE VI.

The authors have to thank the grower and also the Entomological Staff at East Malling Research Station for superintending the application of the spray at this centre, and for subsequent examinations. They have reported the amount of control obtained to be so slight as to make counts unnecessary.

The figures in brackets in the respective Tables denote the number of fruits counted.

Bud Damage.

Some bud-injuries attributable to the sprays employed were observed at Centres I and II.

At the former, such injuries occurred in small groups of trees and, as far as could be ascertained, were coincident with the application of wash from the ends of separate mixings (40 gallon containers). In the case of certain isolated trees a majority of the fruit buds were destroyed.

At Centre II slight bud damage was observed on a majority of trees, without any marked instance of grouping. The freezing of wash (already mentioned) may possibly have been a contributory factor here.

Elsewhere damage was negligible or absent.

Discussion of Results.

Centre I. The apparent control of Capsid Bug as judged in the leaf stage was satisfactory for all varieties and treatments, with the exception of the variety James Grieve sprayed at the later date with the high neutral tar distillate wash.

When the young fruits were examined the results were found to be somewhat unsatisfactory in the case of all those trees sprayed with the high neutral tar distillate wash. Also for the variety Bramley's Seedling the results were poor throughout, with the exception of those trees sprayed with the tar distillate-heavy paraffin (half white) wash.

The results of the early sprayings were not, as a whole, as good as those obtained by means of the later sprayings. The figures for the mature fruits show this to a marked degree. When the mature fruit was examined, it was found in the case of the early sprayings that the results on the variety Worcester Pearmain sprayed with the high neutral tar distillate wash were poor, while in the case of the variety Bramley's Seedling the result was almost a complete

failure. The tar oil-heavy paraffin (white) wash gave good results on Worcester Pearmain, but poor on Bramley's Seedling. Where the half-white oil mixture was used, the control on Bramley's Seedling failed completely and on Worcester Pearmain was not so good as with the white oil mixture.

In the case of the later spraying, the results obtained on the mature fruit show that the amount of capsid marking was low on the variety Worcester Pearmain for all three sprays. Even better results were obtained in the case of the variety Cox's Orange Pippin. The only good figure for the variety Bramley's Seedling was again obtained with the tar distillate-heavy paraffin (half-white) wash. The high neutral tar distillate wash gave better results on the variety James Grieve than those obtained with the tar oil-heavy paraffin (white) wash. Where the half-white mixture was used the results were excellent.

It will thus be seen that the results, while being in a fair number of instances satisfactory, have shown cases of marked inconsistency. This was particularly so with Bramley's Seedling.

An outstanding feature in the case of Bramley's Seedling was the presence of certain small groups of trees in which the infestation was markedly more pronounced than in other trees. One particular tree was noted to have behaved in this manner through three successive seasons irrespective of the type of winter wash applied. Two such trees of Bramley's Seedling were indicated by the grower and the total crop picked and counted separately. A total of 1,242 fruits gave an infestation of 96.5% marked fruit. These trees were in the plot sprayed with high neutral tar-distillate wash (Centre I, Block I), where the average figure for all trees was 52.1% marked fruit.

A similar group of two trees was noted in the case of the variety Cox's Orange Pippin (Centre I, Block II) sprayed with the tar distillate-heavy paraffin (half-white) wash. The marked fruit on these two trees was 50% and largely accounts for the relatively high final figures.

The care taken in the mixing and application of the washes would seem to exclude the possibility of these inconsistencies being due to such causes and points to biological factors yet to be elucidated. The latter also appear to underlie such series of failures as those experienced at the centre at Wilmington, Kent.

In the account of the previous year's work (2) attention was drawn to the relatively large amount of "late" marking by Capsid Bugs on a number of varieties. Such marking was rare in the 1930-31 trials, with the exception of a small number of instances

in the case of the variety Bramley's Seedling and isolated instances in the variety James Grieve.

Centre II. The results were satisfactory as far as could be observed on such a small crop.

Centre III. The results were considered satisfactory. The figures given for the unsprayed plot should naturally be ignored for the later counts. Judging from the leaf counts made on May 21st, the mature fruit would have been heavily marked; in this connection it may be stated that the infestation on mature fruits on these trees in the previous autumn was 73.5%.

Centre IV. A point of interest here, where the crop was light, was that the variety was Lord Derby, which, in previous years in Kent had proved a difficult variety on which to control Capsid Bug in the egg stage.

With the tar distillate-heavy paraffin (half-white) the figures obtained were relatively good.

Centre V. The results in the initial leaf stage were satisfactory. This was the first time of treatment and the infestation was very severe and of long standing. In the final stages high infestations on some varieties were attributed to

- (a) migration of Capsid Bugs from a number of unsprayed and heavily infested black currant bushes situated between the varieties King of the Pippins and Bramley's Seedling and adjoining the variety Cox's Orange Pippin;
- (b) migration from the unsprayed remainder of the orchard, where damage continued to be very severe.

At the young fruit stage, the results were good on the variety Worcester Pearmain, but in the case of the remaining three varieties, near to the black currants, the figures for marked fruit were progressively higher.

Centre VI. The results were a complete failure here for the third year in succession. The cause remains as obscure as before.

On the chance of finding some clue to the cause here and in other anomalous cases from the position of the eggs in the tissues of the shoots of the trees, samples of one and two-year-old wood were obtained from this and other centres during the winter 1930-31. Over 80 Capsid eggs were discovered distributed about equally on wood of both ages. The majority had been deposited in lenticels, with the "cap" flush with the surface: only a few were found to

project in a marked degree. At one Centre (Pinvin. Worcs.) most, were completely buried and grown over, thus being invisible from the exterior: the spray results here, however, were reasonably satisfactory. Hence no light on the inconsistent results has appeared in this direction.

SUMMARY.

1. In general, the results with the tar distillate-heavy paraffin washes have been promising and superior to those of the "high neutral" type. A complete failure at one centre (Wilmington) and a partial one at another (Burlingham) occurred.

At several of the centres the "high neutral" type wash failed to give results satisfactory from a commercial standpoint.

2. The two types of heavy paraffin—"white" oil and "half-white" oil—were generally about equally efficient, although showing some variability in individual results.

3. The results at Burlingham were more efficient with the later application of the treatment.

4. Bud damage occurred at two centres, but not in sufficient amount to be serious.

5. The amount of "late" fruit marking by Capsid Bugs was much less than in the previous year.

6. At one centre Capsid migration from unsprayed interplanted black currants is suggested as a possible cause of the unsatisfactory results on the adjacent trees.

7. The manner in which Capsid eggs were laid showed no apparent relation to the degree of control obtained.

OBSERVATIONS UPON THE INCIDENCE OF
“ REVERSION ” AND THE CONTROL OF
“ BIG BUD ” IN BLACK CURRANTS.

BY THOMAS SWARBRICK AND C. R. THOMPSON.

INTRODUCTION.

The production of a satisfactory crop of black currants in this country would seem to depend, apart from variety, soil and management, upon the control of three diseases, Big Bud, Reversion and Black Currant Leaf Spot respectively.

The control of the last named disease has already been worked out by Marsh and Maynard (1 and 2) at Long Ashton and no further reference to it need be made here beyond a special warning to growers that, where present, it may vwey seriously reduce the yield and render the plantation uneconomic, unless steps are taken to get it under control.

Apart from that disease, Big Bud and Reversion are the most serious pathological troubles which face black currant growers. It is well known that, when they occur, they may reduce the crop almost to vanishing point.

The main purpose of the present paper is to set forth the results obtained at Long Ashton in the cultivation of black currants upon a field scale, where some of the material planted was known to carry reversion. Reverted bushes were planted at known positions upon the plot as definite sources of infection.

Laboratory work and the experimental observations made by the earlier workers suggested that Reversion belonged to the group of so-called “ Virus ” diseases, and in practice it was almost invariably found associated with the occurrence of “ Big Bud ” caused by the presence of the black currant mite in large numbers. Thus the question naturally arose as to whether this mite is responsible for the transmission of reversion from one bush to another. Moreover, the parts played by the sucking and biting insects such as aphides and caterpillars in spreading the disease have not been determined, and the possibilities of spreading the trouble by such

routine operations as pruning, cultivating, picking, etc., remain to be established.

The present experiment was designed to answer some of these questions upon a field scale. As set out above, reverted bushes were planted amongst material apparently healthy. Control measures for insect and fungus pests have been adopted upon an intensive commercial scale. A routine spring application of Lime-Sulphur at 1 in 12 has been applied to control the black currant mite and a winter wash given in order to control aphids. In 1930 and 1931 a Bordeaux wash was applied to control Black Currant Leaf Spot. The preliminary results of this trial are here set forth. The paper also includes new and additional data which aid the grower in detecting reversion, particularly in its early stages.

The Plot.

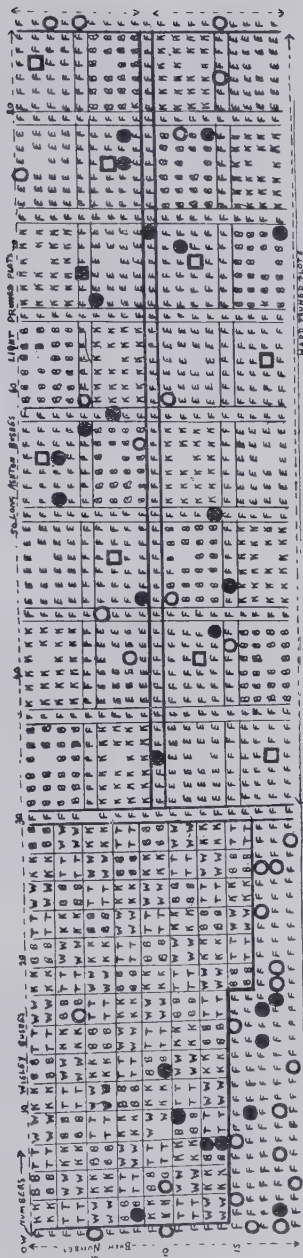
The site upon which the trial was made is about one acre in extent and constitutes a solid 6 by 5 feet plant of black currants. The land is satisfactorily drained with a gentle slope from the S.W. to the N.E. corner. The soil is of medium texture but is stiff at the S.W. corner. A detailed plan of the plot is given in Figure I.

In 1926-27 the plot was in spring cabbage which was followed in 1927 by a bare fallow. In autumn 1927, farmyard manure at 40 tons per acre was applied. In 1928, 1 cwt. of sulphate of potash was given. In 1929, 1 cwt. steamed bone flour, 2 cwts. superphosphate, 2 cwts. sulphate of potash and 2 cwts. of nitrate of soda; 1930, 2 cwts. sulphate of potash and 2 cwts. nitrate of soda; 1931, 3 cwts. superphosphate, 3 cwts. nitrate of soda and 2 cwts. sulphate of potash. The above are all rates per acre.

All material was planted as two-year-old bushes in the winter of 1927-28. The ground has been kept cultivated during summer and is ploughed once during the winter. Crop weights are taken for each bush, and the time taken to pick the crop is also noted. Notes upon the season, fruit quality and incidence of disease in the varieties under trial are also taken. The bushes are pruned during winter and no precautions whatever are taken against the possible spread of reversion by pruning.

The spraying of the plot has been consistent and thorough. Up to 1931-32 the plot has been sprayed each winter with a tar-oil winter wash at $6\frac{1}{2}\%$ concentration. In early spring, a routine lime-sulphur wash at a strength of one in twelve has been applied as a preventative against big bud. Isolated attacks of aphids have occurred from time to time upon individual bushes; these have

Plan of Black Currant Plot Showing Incidence and Spread of Reversion.



B - BALDWIN
 K - BOSKOOP
 E - EDINA
 F - FRENCH (SEABROOKS)
 T - TAYLOR
 W - WESTWICK B. (DANIELSON'S EIGHT)

□ DENOTES BUSHES PLANTED AS REVERTS
 ○ DENOTES BUSHES WITH REVERSION NOTED SPRING 1929
 △ DENOTES BUSHES WITH REVERSION NOTED SPRING 1930
 ◆ DENOTES BUSHES WITH REVERSION NOTED SPRING 1931

been treated as soon as possible after detection with a nicotine dust. The whole plot was sprayed with Bordeaux wash in August 1930 and 1931, owing to attacks of Black Currant Leaf Spot. It will be seen, therefore, that a comprehensive spraying programme on this plot has been designed to control as far as possible the attacks of leaf sucking or biting insects, the Big Bud Mite and the Leaf Spot fungus.

Reference to Figure I shows that the plot is separated into two main sections by a row of bushes of the "French" variety, running north and south. Similar barrier rows divide the bushes on the east side into small blocks of 24 bushes each. These barrier rows are enclosed in heavy black lines on the diagram. The bushes to the west of the barrier row running north and south are planted in groups of four and constitute a variety trial carried out in conjunction with the Royal Horticultural Society, the bushes being supplied from Wisley to Long Ashton by the Society. Each variety from Wisley, viz., Boskoop, Baldwin, Taylor and Davison's Eight, is planted in 26 groups of four bushes, and will be referred to subsequently as the "Wisley material."

The "Long Ashton material" is situated to the east of the barrier row, and comprises the varieties Boskoop, Baldwin, Edina and French. Each of these varieties is planted in 8 groups of 24 bushes to a group. These blocks of 24 bushes are separated from each other by a barrier row of the variety "French" (see Figure I). A large group of French bushes is situated at the south side of the Wisley material. This is a special block of material, and will be discussed later. This material was all raised from cuttings at Long Ashton. All bushes were cut down to the ground level after planting and, apart from the known "reverted" bushes planted as infection centres, the material was apparently healthy.

Special mention must be made to the following point relating to the Long Ashton material since, with the exception of the special block of French bushes mentioned above, it had been very carefully rogued in the nursery. The original cuttings were all taken from bushes of known history. The material comprising the group of French bushes at the south side of the Wisley plot was "ordinary" stock, i.e. the material had not been subjected to any special systematic roguing or selection. This difference in the initial material is important, as will be evident later. The French bushes comprising the barrier rows in the Long Ashton trials is mostly "selected" material similar to that in the Long Ashton groups. A small admixture of "unselected" material was used in these barrier rows in order to complete the planting.

The pruning of the barrier row bushes and of half of the Long Ashton groups was a "light pruning," i.e. the complete removal each year of about one-third of the bush, choosing always the oldest branches. In the hard pruned blocks in the Long Ashton trials, approximately half of the bush is removed each year.

The incidence and spread of reversion have been determined by careful surveys made on several occasions each year.

I.—OBSERVATIONS ON THE SPREAD OF REVERSION AND THE INCIDENCE OF BIG BUD.

Reversion.

Reference to Figure I shows that eight reverted bushes of the "French" variety were planted in 1927-28 as infection centres in the Long Ashton Plots. The blank places in the other varieties were left with the intention of planting reverted material, but this intention has not been completed since reverted material of these varieties has only recently become available. The spread of reversion in the whole plot in successive years is shown by a system of markings upon Figure I. These markings are fully explained in the figure and no further reference to the particular marking employed is therefore necessary.

Even a casual survey of Figure I brings out two very interesting points. The first is the presence of an abnormally large number of reverted bushes in the "ordinary" French bushes in the S.W. corner of the plot below the "Wisley" material; the second is the comparative freedom from reversion of the "Wisley" material. Reversion appears fairly equally distributed over the remainder of the area.

Coming to a more detailed examination of the plots, a beginning will be made with the heavily infected block of the variety French in the S.W. corner. In spring 1930, approximately 12% of these bushes had developed reversion, and in spring 1931, 5 more bushes, or approximately 4% of the remainder, also developed the disease. This is a very heavy casualty list, and is undoubtedly related to the fact that this material was not systematically rogued in the nursery.

The "Wisley" material, as was pointed out above, is comparatively free from reversion. In this material only two cases occurred in 1930 and five more in 1931. It is noteworthy and possibly significant that these seven cases are all in the variety Baldwin. It is pointed out that the appearance of reversion in the Wisley Plot is later in time, and has appeared mainly near the block of heavily reverted "ordinary" French bushes in the south-west corner of the site.

It is interesting to compare the incidence of reversion in the block of "ordinary" French bushes with the "selected" French in the series of Long Ashton material. Neglecting for a moment the material known to be reverted at planting, out of 184 "selected" French bushes planted, only 7 have developed reversion. This is approximately 4% and contrasts significantly with the 20% infection in the "ordinary" block of French. This observation constitutes a very strong argument for the exercise of care in the selection of cutting material.

As regards the appearance of reversion in relation to the known centres of contamination, there is very little evidence to connect the appearance of reversion upon the plot with these centres of infection. In only two of the "Long Ashton" series of plots has reversion developed in the bushes adjoining an "infector" bush. On the other hand there are four plots where "infector" bushes are still surrounded by clean bushes. It might be argued that the incidence of reversion in the "Wisley" material is due to the presence of the large number of reverted bushes in the adjoining plot, but here again it is pointed out that the infection of the "Wisley" material is confined solely to the variety Baldwin, and that one reverted bush has appeared in the centre of the plot at a considerable distance away from any other infected bush. The evidence suggests that the incidence of reversion upon these plots is not grouped about the "infector" bushes, but is subject to certain varietal susceptibilities, and is scattered indiscriminately over the whole area.

It should be noted that there is not a single case of reversion in the variety Boskoop over the whole plot. The varieties Edina and Baldwin also appear to be relatively free from reversion, and on the "Wisley" plot the varieties Taylor and Davison's Eight are also free. It is clear that the major incidence of the disease has been in the French variety and to a much less extent in Baldwin and Edina.

The relation of the spread of reversion to pruning, picking and cultivating also appears to be of a negative order, although no precautions whatever have been taken. In fact, on the heavy pruned Long Ashton Plots only six bushes have developed reversion, whereas there are eight cases on the lightly pruned plots.

Big Bud.

The incidence of Big Bud upon this plot has been negligible. Only two bushes have developed a few big buds, which were noted in the winter of 1929-30. These infected buds were picked off and destroyed. In the whole history of the plot, these are the only

big buds that have been found. As mentioned earlier, a routine spraying with lime-sulphur has been applied each spring as a control measure. The effectiveness of this measure is obvious, since a heavy source of infection has been present in an adjoining field. The spread of reversion in the plot, therefore, can be regarded as having taken place in the absence of big bud amongst the bushes.

General Review and Discussion.

It is evident that the measures adopted for the control of the Big Bud mite have been effective, since only two bushes have been found with big buds during the period 1927-31. This is a complete commercial control obtained with a source of infection in an adjoining field. It does not follow, of course, that because there is no Big Bud on these bushes they are completely free from mites, since there may be a small population of mites upon the bushes without their giving rise to the swollen buds so evident a feature of a heavy mite infestation. It may be asserted, however, that the incidence and spread of reversion upon the plot has occurred in the absence of Big Bud symptoms.

It is also stressed that there has been no widespread attack of aphid upon these bushes. It is admitted that a few aphides have from time to time been seen upon some of these bushes, but when found these have been dusted at once with a nicotine insecticide. The plot has been remarkably free from any pest, and may be regarded as having been as free from pests as is possible under field conditions. It is certain that under commercial conditions the bushes could not have been kept in better condition or more free from any pest or fungus disease.

The data show that the incidence and spread of reversion upon the plot are not grouped about the known centres of infection. This is perhaps somewhat surprising, since these centres of infection have been present on the plot throughout four consecutive summers. The distribution in fact appears to be of a random nature, appearing without reference to any known factor.

It is probably significant that no cases of reversion were noted in 1928-29, but that a considerable number were recorded in spring, 1930. It is also interesting to notice that the "unselected" French variety showed so many reverted bushes in spring, 1930. These were undoubtedly scattered throughout the whole of this material. Similarly two cases of reversion appeared in the Baldwin variety of the "Wisley" material. These two cases were also very widely separated. In the "Long Ashton" plots two cases of Edina and one in Baldwin appeared all widely separated and not in

close proximity to "infector" bushes. It is clear that there was a random appearance of reverted bushes over the plot in 1930. The appearance of new cases of reversion in 1931 is also scattered over the plot in a random manner, except perhaps in the block of "unselected" French material adjoining the "Wisley" Plot. In this case also there is the possibility that this "unselected" French material may have been the source of infection for the Wisley material, which developed reversion in 1930. It should be pointed out, however, that in the "Wisley" material only the variety Baldwin is affected.

The above considerations raise the problem of how these bushes were infected. Clearly, infection cannot be related to the known sources of contamination on the plot. The possibility is suggested that the bushes which have now shown reversion carried the disease in an incipient stage when planted. The comparatively large number of bushes of the "unselected" French material which were reverted in 1930, and the appearance of the two widely separated cases of Baldwin in the "Wisley" material, considerably strengthens this suggestion.

The suggestion raises the question as to how long it takes reversion to develop in black currant bushes to the stage when diagnosis becomes possible, when the bushes are growing under natural conditions in the field. It is known that under artificial methods of inoculation the disease may appear very quickly, but the evidence of the plot at present under discussion does not suggest that the cases of reversion so far recorded have been infected from the centres of known contamination. In fact, there are many cases where reverted bushes planted as such in 1927 are still surrounded by healthy bushes. The rate of the development of the disease in a bush growing under field conditions is obviously important both to the grower and the experimenter since, if the disease is incipient for one or more years, the necessity for care in the roguing of propagating material becomes even more urgent. In any case, the diagnosis of the disease in its earliest stages becomes of great practical and experimental importance. In the next section of this paper an additional diagnostic feature for the detection of reversion is given. This feature makes it possible to detect reversion in a bush at a much earlier stage than is possible by the use of the features at present in general usage.

II.—THE DIAGNOSTIC SYMPTOMS OF REVERSION.

During the course of the work outlined above, a new feature of reverted bushes has been noted, and this appears to have considerable diagnostic value. Earlier workers have described certain

diagnostic features by which reversion may be detected, and these are now in common use. These features lie particularly in the foliage and floral characters of bushes suspected of becoming reverted. For the sake of completeness these established diagnostic features are given in a condensed form, and are followed by the additional features which draw attention to the foliage colour and fruit character of bushes suspected of reversion.

The most commonly used features in roguing for reversion are the leaf margin characters, leaf venation and floral characters. A coarseness of the leaf margins is very evident in reverted bushes, the leaves appearing almost like nettle leaves. This is brought about by a reduction of the network of small veins and by a reduction of the number of lateral veins arising from the central main vein. Where the number of laterals arising from the central main vein falls below five reversion should be suspected. A confusion is likely to arise, however, between "false" and "true" reversion. Heavy manuring, hard pruning and the subsequent growth following an attack of aphid all tend to give an appearance of reversion to the foliage. It is also difficult to rogue cuttings the first year in the nursery because of the tendency to slightly abnormal foliage.

Another well known feature by which reversion may be detected is the flower colour at the opening bud stage. The normal flower bud of the black currant is pinkish brown in colour, but is covered with a dense, short down which gives a dull whitish sheen upon the pink-brown background. In reverted bushes, this down is absent and the buds appear a chocolate brown with a distinctly polished appearance. This symptom is very reliable indeed, but requires a great deal of patience in its use. Because of the time involved, it is difficult to rogue large areas using this method of diagnosis. The period of its usefulness each year is also very limited.

The following two features, associated with foliage colour and fruit respectively, are additional diagnostic characters discovered during the course of this work. The former appears to be of considerable importance to both grower and nurseryman, since it appears in a bush prior to the other symptoms by which reversion is at present recognised

1. *Foliage Colour.*

For a period of about a month during spring, reverted bushes can easily be recognised, even at a distance, by the light colour of the foliage as compared with that of normal bushes of the same variety. Although, as is well known, there are considerable differences between varieties in the colour of the foliage, yet notwithstanding this varietal difference, the above statement holds

good within every variety upon the plots here under discussion. Even in Edina, which normally has pale yellow-green foliage, the reverted bushes are distinguished from the rest by their paler foliage colour. For two years, this variation in colour intensity has been recorded at Long Ashton. It was evident from the 6th May to the 1st June in 1930, and from the 4th May to the 8th June in 1931. After the beginning of June, this foliage colour difference disappears. After having the difference indicated to him, a casual (untrained) observer was able, from a small rise behind the plot, to indicate almost every reverted bush upon the plots. It has been noted that an absence of down is characteristic of reverted bushes. This may account to some extent for the colour difference in the foliage. This feature—unless it should prove subject to very considerable seasonable variations—offers a very ready additional method of diagnosis, since even bushes which can only be suspected of going “revert” by the other features, stand out clearly by their lighter foliage colour: it is thus, so far as at present known, the earliest observable symptom.

2. *Fruit.*

Fruit from bushes suffering from reversion is quite characteristic when viewed in bulk. The crop from a badly reverted bush, of course, is negligible. In less severe cases the fruit is characterised by appearing to possess a lot of stalk. The fruit stalk or rachis of the fruit from reverted bushes is short, very bright green in colour and devoid of down. The rachis carries several flowers many of which may be abortive and undeveloped. The fruits that have developed are small, very bright in colour and rather hard in texture. The withered sepals of the flower always remain very conspicuous indeed upon the fruits of reverted bushes, and the scent glands tend also to be very much more noticeable on the fruits in such cases. These features, while they may not be strongly evident during the initial stages of reversion in a bush, may be used to confirm a suspicion developed during the earlier part of the year from observations upon foliage characters.

It would seem that, with a little care and attention, reversion can now be readily diagnosed in the early stages by the commercial grower and the bushes replaced. The roguing of material in the nursery is admittedly much more difficult, but the new feature of foliage colour should be of considerable assistance to the nurseryman in particular.

SUMMARY AND CONCLUSIONS.

1. A report is given of the incidence and spread of reversion in a specially planned block of black currants during the first four years

following planting. A few reverted bushes were deliberately planted at suitable positions to serve as centres of infection. During pruning no sterilization of the pruning knife was attempted. Possible carriers of reversion such as sucking and biting insects and the Big Bud Mite have been effectively controlled by spraying measures.

2. There has been no spread of reversion which could be unquestionably associated with the known centres of infection. There is, however, slight evidence that the "Wisley" material may have been infected from the adjoining block of "unselected" French bushes. The relatively high percentage of cases of reversion which have developed in the latter shows the disastrous consequences following upon the indiscriminate planting of unselected material.

3. The general distribution and occurrence of reversion on the plot suggests that it may have been incipient in the bushes when planted, rather than produced in them after planting.

4. Not a single bush of the variety Boskoop has become reverted, and the varieties Taylor and Davison's Eight are also as yet without a single case of reversion, although the number of bushes of the two latter varieties upon the plot is small. The "French" variety appears to be the most susceptible of those planted on this plot.

5. Two additional characters of diagnostic value for roguing black currants plantations have been discovered:—(a) a characteristic pale yellow colour of the foliage in mass during May; (b) a prominent appearance of the rachis when the fruit is in the baskets. The former character is considered of great usefulness to nurserymen in view of ease of detection and since it appears before a bush can be definitely classed as reverted by any other symptoms.

REFERENCES.

- (1) MARSH, R. W. and MAYNARD, J. G. "A Preliminary Note on the Control of Black Currant Leaf Spot" (*Pseudopeziza ribis*). (*Ann. Rept. Long Ashton Research Station*, 1928, p. 109.)
- (2) Do. "Supplementary Note on the Control of Black Currant Leaf Spot." (*Ibid*, 1929, p 166.)

SOME OBSERVATIONS ON THE CONTROL OF THE APPLE SAWFLY

HOPLOCAMPA TESTUDINEA (KLUG).

BY H. G. H. KEARNS AND T. SWARBRICK.

Introduction.

During the past few years, the Apple Sawfly has become an increasingly serious pest in the Bristol Province. In 1931, reductions in crops even more serious than in previous years occurred as a result of attacks of this pest, particularly in the varieties Worcester Pearmain, Cox's Orange Pippin, James Grieve and Early Victoria. In some cases the losses were so serious as to make the crops unprofitable. To the urgency of the case and the pressing enquiries from growers for control measures must be attributed the publication of the following account of a preliminary experiment, the conclusions arising from which require to be subjected to a further series of experimental tests already planned :—

In 1927 and 1928, Petherbridge and Tunnington (1) obtained a satisfactory control of the Apple Sawfly by the application of a nicotine soap wash at definite intervals of time after petal fall. Some experiments of a similar nature were therefore carried out in 1930 by Staniland and Walton in the Bristol Province. In these experiments a number of insecticides, including nicotine soap, were applied at the approximate periods recommended by Petherbridge and Tunnington. The results of these trials were unsatisfactory, and it was evident that experiments were necessary in the Bristol Province in order to determine the optimum period for spray application in the South-Western Counties.

Life-History and Habits of the Apple Sawfly.

The adult sawfly has a small body about $3\frac{1}{16}$ ths inch long, with a dull black appearance, as seen from above. The underside of the body and the legs are reddish-yellow in colour. The wing span is about $\frac{1}{2}$ inch.

The flies emerge from cocoons in the ground at about the time when apple trees are in full blossom. The adult flies may often be found at this time of the year resting on the open flowers, especially on still sunny days. The females deposit one egg upon

each flower below the calyx cup. The incubative period of each egg is about ten days. Upon hatching from the egg, the larva may either commence at once to burrow its way into the young fruitlet or it may wander over the surface of the fruitlet for a short period before beginning to burrow into it. The larva does not enter completely into the fruit for some time, but allows the posterior end of its body to protrude from the surface of the fruitlet for some time. Eventually it enters completely into the apple and disappears from view, leaving only a very small hole where it entered.

It is during the period between the larva hatching from the egg and the time when it disappears into the fruitlet that it is possible to obtain control of the pest. For this purpose a contact insecticide is required. Since the period during which the larva is on the surface of the fruitlet is short, the timing of the spray application is important. Not all the eggs are laid on the same day: so they hatch out over a period. This fact has also to be borne in mind when devising a spray programme for the control of this pest. In the experiments of Petherbridge and Tunnington (1), for example, it was found that two applications of a nicotine spray gave a much better control than one application, indicating that in this case there had been a protracted egg laying period.

Observations of the habits of the sawflies were made during the blossoming and post-blossom period of spring, 1931. Adult sawflies were seen in considerable numbers at the beginning of the blossom period on the upper portions of the flowers, particularly during the sunny intervals in the morning. The sawflies appeared to be feeding upon the pollen. On some occasions they were very active and were found crawling about amongst the pedicels of the inflorescence. Several specimens were captured and were found to have a full complement of mature or almost mature eggs. It was evident that the flowers of the variety Worcester Pearmain were more frequented by the sawflies than any other of the varieties that were in blossom at the same time and were adjoining. Whether this was a coincidence or a definite preference remains to be proven. It is probably significant that Worcester Pearmain has been found in many plantations to be the most commonly attacked variety.

Experimental Methods and Material.

An experiment was planned in spring 1931, in which eight similar groups of trees were sprayed with a nicotine wash at increasing intervals of time after petal fall. In this work, "petal fall" was taken as the period when the majority of the petals fell

when the branches were subjected to a slight vibration by tapping upon them.

A block of ninety six eleven-year-old trees of the variety Worcester Pearmain were available on one of the Rootstock Plots at Long Ashton. These trees were particularly suitable since their history and performance have been carefully recorded every year since planting. They had also suffered severely from attacks of Apple Sawfly during the seasons 1929-1930. In 1930, the attack was so severe that over half the crop was lost. The trees are planted in twelve groups of eight in successive rows, the eight trees in each case being upon a uniform rootstock. It was thus convenient for the purposes of this experiment to arrange to take eight groups of twelve trees across the plot, so as to provide one tree upon each of the twelve rootstocks in each group. The groups therefore were similar in every respect. One group was left as a control and the remaining seven were sprayed at successive intervals of time with a nicotine wash made up as follows :—

8 fluid ounces of Nicotine (98 per cent. purity).
 2½ lbs. Agral I (=0.25 per cent. solution).
 100 gallons water.

The wash was prepared immediately before use and applied with a power sprayer at about 160-180 lbs. pressure per square inch. Since it was essential from the nature of the case, particular care was given in the application of the wash so that the fruitlets were thoroughly wetted. The larvae being so small and the wash a contact insecticide, a thorough wetting of the fruitlets is essential, and in practice it is admittedly difficult to wet the young fruitlets below the calyx cups.

Seven spray applications were made, starting on the 1st June, 1931. This date was three days after petal fall for the variety Worcester Pearmain at Long Ashton. Subsequent spray applications were made on the 4th, 5th, 6th, 7th, 8th and 12th days after petal fall. The weather both at the time of spraying and subsequently was carefully noted. Spraying was only carried out when the fruitlets were dry; when rain fell within an hour after the spray was put on, the subsequent weather was recorded as "wet." Each tree required about 1½ gallons of spray fluid. Due care was given during each spraying to confine the spray to the group of trees under treatment.

Experimental Results.

The results of the experiment are given in Table I. The fruit "set" upon each tree in the experiment was determined about fourteen days after petal fall. This fruit "set" for the individual

trees is not given in Table I, but the total for each group is given at the foot of the table. A comparison of these totals shows that the groups were very uniform in the matter of total fruit set. In the middle of July when all the larvae had emerged from the fruits, the trees were carefully picked over and all infested apples collected. The windfalls were also collected and all infested fruits among these added to those picked from the trees.

The total number of infested fruits from each tree of each group is set forth in Table I. This is also expressed as a percentage of the total fruit "set" for the tree in question. From these figures the variation from tree to tree within the group can be observed. The nett result of the experiment is shown at the foot of the table by expressing the group total of infested fruits as a percentage of the total number of fruits set.

It is seen from the results expressed in Table I that the control group of trees showed a very high infestation, over 54 per cent. of the total fruits having been attacked. This represents a loss of over half the possible crop. Contrasted with this high infestation, the groups 1 to 6 show not more than 13 per cent. infestation. The most effective control was given by the spray application made on the 5th day after petal fall, where only 5.6 per cent. of the fruits were infested. It is clear, however, that as compared with the unsprayed group of trees, the sprayings from the 3rd to the 8th day after petal fall have given a good control. The infestation in fact has been reduced from 54 per cent. to 13 per cent. or less by spray applications within this period.

The spray application made on the 12th day after petal fall shows a reduction of the infestation from 54 per cent. down to 34 per cent. The effect of this particular application is difficult to evaluate since rain fell within an hour after the spray was applied (unfortunately no further trees were available for spraying). Against this, it should be mentioned that rain fell within an hour of the spray application made to the 5th group, where the control was satisfactory. Further data are urgently required of the influence of the weather upon the effectiveness of the sprays that might be used as contact insecticides against the Apple Sawfly. Previous experience with a nicotine wash would lead one to expect that an hour would be sufficient time in which to effect a kill of the larvae when they are wetted with the wash.

The control of the Sawfly is shown to have doubled the crop as compared with the unsprayed group of trees. In the control group of trees where the infestation with Sawfly was 54 per cent. the total crop yield was only 209 lbs. of fruit from the twelve trees,

TABLE I.
Showing the Control of Apple Sawfly as Effected by a Nicotine Spray applied at Successive Intervals of time after Petal Fall.

Group No. and Date of Spraying.	(1) 1/6/31	(2) 2/6/31	(3) 3/6/31	(4) 4/6/31	(5) 5/6/31	(6) 6/6/31	(7) 10/6/31	(8) Control.
No. of Days after Petal Fall.	3	4	5	6	7	8	12	Control.
Rootstock.	Total No. of Infested Fruits	Total No. of Infested Fruits	Total No. of Infested Fruits	Total No. of Infested Fruits	Total No. of Infested Fruits	Total No. of Infested Fruits	Total No. of Infested Fruits	Total No. of Infested Fruits
% of Infested Fruits	% of Infested Fruits	% of Infested Fruits	% of Infested Fruits	% of Infested Fruits	% of Infested Fruits	% of Infested Fruits	% of Infested Fruits	% of Infested Fruits
East Malling—								
No. I	95	128	12	104	42	168	223	415
II	41	80	14	48	48	153	286	364
III	59	155	37	103	26	86	136	219
IV	79	51	15	91	34	74	194	208
V	14	11	64	31	8	37	150	219
VI	30	73	31	62	14	16	120	190
VII	39	11	5	14	30	36	116	228
IX	24	6	1	5	6	18	12	249
X	30	60	18	10	23	68	135	169
XII	16	50	5	18	35	45	124	214
XIII	28	29	23	2	16	32	128	154
Long Ashton—								
No. G8	91	52	95	91	72	90	206	284
Total No. of Fruits on Trees	5756	5455	5711	5317	5309	6319	5286	5315
Total No. of Infested Fruits	546	706	320	489	354	823	1830	2913
Group % of Infested Fruits	9.4	12.9	5.6	9.0	6.6*	12.9	34.6*	54.8

* Rain fell within an hour after the spray application was made.

whereas in the groups 1 to 6 where the infestation was reduced to 13 per cent. or less the yield was not less than 500 lbs. and in group 1 was as much as 724 lbs. from twelve trees. This doubling of the crop is an outstanding achievement. These data also indicate the extent to which attacks of Sawfly may reduce total crop yield.

It is clear from this trial that a nicotine wash applied during the period three to eight days after petal fall can give a satisfactory control of the Apple Sawfly. Seasonal variations from year to year may possibly influence the degree of control that may be obtained and further trials are needed. It is intended to carry out trials upon a larger scale at Long Ashton during 1932.

SUMMARY.

1. The periodicity of the life cycle of the Apple Sawfly has been observed in the Bristol Province, and a brief sketch of the life history is given with particular reference to its vulnerable period.

2. A trial was carried out applying a nicotine wash at successive intervals of time after petal fall.

3. A satisfactory control was obtained on the variety Worcester Pearmain in 1931 by spraying with a nicotine wash between the 3rd and 8th day after petal fall.

4. The wash consisted of:—

8 ozs. Nicotine.

2½ lbs. Agral I (as a wetter).

100 gallons water,

applied under a pressure of 160-180 lbs. per square inch.

REFERENCE.

- (1) PETHERBRIDGE, F. R. and TUNNINGTON, F. The Control of Apple Sawfly. *Journ. Min. of Agric.*, February, 1929, pp. 1055-1059.

HARD ROT OF STRAWBERRY FRUITS.

BY LAWRENCE OGILVIE.

In the summer of 1930, some 80 per cent. of a crop of strawberries of the variety "Paxton" grown on a Herefordshire farm were found to be affected with a peculiar "hard rot." The fruits had hard brown sunken areas with a large number of seeds which prevented proper "plugging." Such fruits were useless for canning purposes and had to be thrown out.

The disease was again serious in 1931 in the northern parts of the Province where the variety "Paxton" is grown for canning.

The disease on the fruits was found to be associated with a *Septoria* which also causes spots on the leaves and withering of flower stalks and sepals. The leaf-spots are somewhat circular, about $\frac{1}{2}$ cm. in diameter, with brown centres and reddish purple margins. Abundant pycnidia are found in the centres of the spots.

The pycnidia are black and sunken, about 100μ in diameter and 125μ in height, and the conidia cylindric, somewhat curved, obtuse, usually 3-septate, slightly constricted at the septa, and average $40 \times 5\mu$.

Small purple spots may appear on the sepals, which later become brown and covered with pycnidia. Such sepal infection leads to infection of the green fruits and development of the hard areas already described.

Much damage may also be brought about by the fungus causing shrivelling of the flower stalks and the flowers themselves.

The fungus in question has been obtained in pure culture and has been provisionally identified as *Septoria Fragariae* Desm. The same fruit damage was described by Miss Lorrain Smith (1) from material sent from Southampton in 1903, but no subsequent reference to the disease has been found.

A paper dealing with the synonymy of the fungus is in course of preparation.

Trials which have been carried out to date indicate that some control may be obtained by spraying the plants with Bordeaux mixture previous to fruiting.

ILLUSTRATIONS.

FIG. 1.—Typical leaf-spots caused by *Septoria Fragariae*.

FIG. 2.—Affected flower stalks and sepals.

FIG. 3.—Affected sepals.

FIG. 4.—Fruits affected with "hard rot."

- (1) LORRAIN SMITH, A. "Diseases of Plants due to Fungi—*Septoria Fragariae*." *Trans. Brit. Myc. Soc.* 2, 1903, p. 56, 1904.



FIG. 1.



FIG. 2.



FIG. 3.

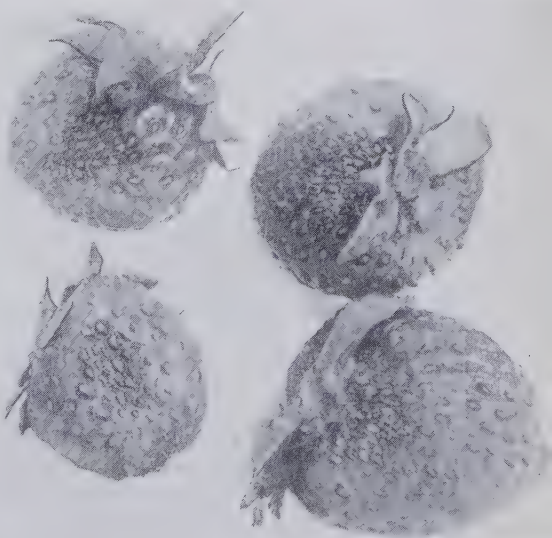


FIG. 4.

PROGRESS REPORT ON VEGETABLE DISEASES.—III.

BY L. OGILVIE AND B. O. MULLIGAN.

The following report deals with the further progress made in the season 1930-31 towards the elucidation and control of diseases of vegetables in the Bristol Province, with special reference to the Evesham and Cheltenham areas, and is a continuation of the reports published in the two previous years (3, 4). In the course of the work, special emphasis has been laid on the control aspect. When the investigation of certain of the diseases is completed, detailed papers will be published. The first of these, dealing with "halo blight," a bacterial disease of dwarf beans, is now in course of preparation.

ASPARAGUS DISEASES.

Violet Root Rot of Asparagus (*Rhizoctonia Crocorum*, ? = *Helicobasidium purpureum*). A continued survey of the asparagus beds in the Evesham area has revealed only one more affected plot, and this, like the five others previously discovered, is only several yards in diameter.

In one case concerning which reliable information was obtained, a rotation of seven years was insufficient to free the infected ground from the fungus. In the succeeding asparagus crop, signs of the disease appeared in the third year after planting (and first year of cutting), when the shoots commenced to turn yellow. As reported last year *Rumex obtusifolius* may become infected and may serve to carry over the disease.

In view of these aspects of the problem, it was resolved to attempt partial sterilisation of the affected soil by means of certain chemicals on the lines on the experiments previously carried out by Barker and Gimingham (1). The following chemicals were applied: formalin, copper sulphate, cresylic acid and chloride of lime. The treated ground is to be planted up in 1932 with young asparagus plants.

Attempts to infect carrots and parsnips grown from seed in sterilised soil with pure cultures and with pieces of diseased roots have as yet been unsuccessful.

Zopfia rhizophila. As reported last year, *Zopfia rhizophila* was found on certain plants from the Evesham area. In 1931, another infected locality was discovered. Although the stems and foliage showed premature yellowing, the perithecia of the fungus were found only on dead roots and were markedly superficial.

Attempts to culture the fungus were unsuccessful. Pieces of infected roots were added to three healthy plants growing in sterilised soil, but no infection was observed after the lapse of one year. There is as yet, therefore, no proof that *Zopfia rhizophila* is parasitic.

References to previous literature on the subject will be found in a recent note in the "Gardeners' Chronicle," by Salmon and Ware(8).

DISEASES OF DWARF (FRENCH) BEANS.

Bacterial Disease. This disease was recorded for the first time in England in last year's report. Surveys made this year in the Evesham area have emphasised the serious and widespread nature of the disease. Of the varieties commonly grown in the area, "Canadian Wonder," "Early Prolific" and "Masterpiece" are all highly susceptible.

Laboratory work on the causal organism has proved its identity with *Bacterium Medicaginis* var. *phaseolicola*, which is now known to occur in Germany, Holland and Australia, besides the U.S.A., from which it was first described. A full account of the cultural characteristics of the organism and the symptoms of the disease on the plant will be given elsewhere.

Our field experiments have shown that the disease may be checked by roguing, if this is carried out soon after it makes its first appearance in the "halo blight" stage. This is especially the case when the first occurrence of the disease is localised.

Our pot experiments have shown that seed from infected pods may produce diseased plants and, from a consideration of many cases of infection in the field, we have come to the conclusion that ground which has borne diseased plants may not necessarily bear infected plants in the following season and that most of the field infection arises from infected seed.

Attempts were also made to control the spread of the disease in its early stages by dusting with copper-lime dust, but no appreciable effect was observed in comparison with undusted plots.

The chief hope of control appears to be in the use of resistant varieties and, as our trials in this direction are of some practical interest, they are described here in more detail.



PLATE I.
"Halo blight" of Dwarf Beans. Typical "halo" leaf spots.

For the purpose of the trials, a piece of land was used which had borne a severely infected crop in 1930, and our thanks are due to Mr. W. J. Newman, of Hinton Cross, near Evesham, who supplied both ground and labour for these trials.

The arrangement of the varieties in the rows was as follows :—

1	2	3	4	6	8	10	13	14	18	20	21	22	23	25	26	27
			5	7	9	11		15	19				24			
						12		16								
								17								

The names of the varieties to which the above numbers refer are given in Table I.

The seed was sown in mid-May, Nos. 18–27 being put in a week later than the others ; the ground for Nos. 1–17 inclusive received a dressing of hoof and horn, but otherwise no manures were applied throughout the season. The beans were grown between strawberry rows, and the soil is a sticky clay.

The seeds were obtained from the following sources, and to each of these firms we are indebted for their supply :—Messrs. E. Benary, Erfurt, Germany ; W. Atlee Burpee Co., Philadelphia, U.S.A. ; Carter's Tested Seeds Ltd., Raynes Park, London, S.W. ; J. L. Clucas, Ltd., Ormskirk, Lancs. ; Chas. Sharpe & Co., Sleaford, Lincs. ; J. C. Wheeler & Son, Gloucester ; and Yates & Sons, Ltd., Evesham. Dr. W. H. Burkholder, of New York, also sent us samples of three varieties.

Different quantities of seed, ranging from one quart downwards, necessitated different lengths of rows. It will be noted in the above diagram that the majority of the varieties were grown in adjacent rows, in a few cases more than one variety occurring in a row.

The average number of plants per yard with thick sowing and good germination is ten, but with the majority of varieties seven or eight was a more usual number.

The results of the trial are given in Table I.

TABLE I.

	<i>Variety.</i>	<i>Length of Row. yds.</i>	<i>1st Count (29.6.31)</i>	<i>2nd Count (13.7.31)</i>	<i>3rd Count (27.7.31)</i>
			<i>Number of Plants Infected.</i>		
1	Black Prince	100	2	84	310
2	Canadian Wonder	100	47	207	508
3	Masterpiece	100	260	416	452
4	Early Prolific	48	123	190	195
5	Canadian Glory	49	70	110	270
6	White Model	68	36	90	285
7	Fifty Days	29	16	48	110
8†	Ne Plus Ultra	57	12	21	91
9 }	Sultan	42	0	2	48
12 }					
10	Early Queen	23	62	87	106
11	William's Earliest of All ..	65	7	12	91
13*	Superlative	87	20	28	156
14†	Black Wonder	63	20	40	148
15	Rogers' Stringless Refugee ..	23	1?	1	46
16	Refugee 1000-1	15	0	1	50
17	Robust Pea Bean	2	0	0	1
18	Selected Exhibition	47	0	1	14
19	Market Favourite	37	9	15	68
20	Early Saxony	100	0	2	28
21*	Incomparable	100	8	17	258
22	Flageolet St. Andrew	100	22	58	417
23	Unrivalled	58	4	32	87
24*	Magpie	46	0	4	23
25	Flageolet Victoria	100	56	128	304
26	Black Prince	100	9	64	278
27	Black Prince	100	—	38	238

* Best varieties.

† Can be recommended.

NOTES RELATING TO TABLE I.

Row.

- 1 Poor growth at this side of plot. Probably infected by No. 2 in the later stages: but good at earlier counts.
- 2 Infected to a large extent by No. 3, but not entirely. Very susceptible.
- 3 85% (approx.) infected at 2nd count, and finally 100%. Pods much twisted by disease. Highly susceptible.
- 4 The commonest market variety; very susceptible to "blight."
- 5 Almost 100% infection. Fair crop, but pods too short for market use.
- 6 Badly attacked by disease, including pods. Not a market bean.
- 7 Majority of plants infected. Pods short, soon becoming thickened.
- 8 Very fair; bean medium length, rather wide.
- 9 } Very poor germination; practically 100% infection at final count. Pods
- 12 } useless for market.
- 10 100% attacked; most susceptible. Fair crop of rather short pods, widening at the end. A number of plants appeared to be infected with mosaic from 2nd count onwards.
- 11 Very poor germination. Plants very variable in cropping; pods long and often bent.
- 13 A promising variety. Even at final count most of the infection was only of the mild "spot" type. Good crop; pods long and straight.

14. Very fair resistance to disease. Good crop; pods rather wavy, long, sometimes infected.
- 15 } American varieties, highly resistant to disease, since only slight "spots"
- 16 } appeared late in season; but a fortnight later than all others and hence
- 17 } useless for commercial work.
- 18 Bad germination, otherwise possibly useful. Good cropper, pods long and straight.
- 19 Light infection; good crop, but pods rather short and broad. Mosaic present.
- 20 Very resistant to disease. Good crop of pods of medium length, but thick and narrow; not a market variety.
- 21 Infected late by No. 22, but spot only on leaves. Very fair crop of straight and even pods; compact habit of growth; of value commercially.
- 22 A susceptible variety. Good crop, but beans rather long and inclined to curve. Pods infected.
- 23 Germination not too good. Poor foliage, and "running off" of the young pods occurs at the top of the plant.
- 24 Very clean foliage and good crop; pods medium length, straight or slightly upcurved at tip.
- 25 Generally infected. More growth than crop; pods flat, medium length, sometimes infected.
- 26 } Good growth and crop. Disease mainly in patches and probably from
- 27 } No. 25. Generally a fairly resistant variety.

In making counts, all plants which showed any infection whatever were included, although this might be only one spot on a leaflet. Many of those numbered in the first count subsequently became entirely brown and dried up, but were included in the later counts so long as still present in the row.

The following varieties were ready for picking at the time of the third count (27.7.31):—"Canadian Glory"; "Early Prolific"; "Early Queen"; "Fifty Days"; and "White Model." "Black Wonder"; "Market Favourite"; "Masterpiece"; "Ne Plus Ultra"; and "Superlative" were almost ready.

Of those sown a week later, none were then ready for picking, but "Incomparable" appeared to be the earliest.

On 7.8.31 only the American varieties—Nos. 15, 16 and 17—were not in full bearing, and had not even commenced to pod; "Rogers' Refugee" is probably the earliest of these. A fortnight later they were fully mature.

As a result of these trials, the varieties concerned may be arranged as follows:—

Highly Susceptible.

Canadian Glory.
Canadian Wonder.
Early Prolific.
Early Queen.
Fifty Days.
Flageolet St. Andrew.
Masterpiece.
White Model.

Susceptible.

Black Prince.
Flageolet Victoria (Magnum Bonum).
Market Favourite.
Sultan.
William's Earliest of All.

Resistant.

Black Wonder (partially).
 Incomparable.
 Magpie.
 Superlative.
 Ne Plus Ultra (partially).

Resistant, but useless for market.

Early Saxony.
 Refugee 1000-1.
 Robust Pea Bean.
 Rogers' Stringless Refugee.

It should be noted that in several cases, (e.g. "Black Wonder") the high figure at the third count does not always mean high susceptibility to the disease, but usually was due to a large number of small and slight infections which at that stage would have little or no effect on the crop.

When estimating susceptibility, the figures for all three counts should be taken into consideration.

"Lightning," on the remainder of the ground, was noticeably infected at the time of the first count, with many bad patches all through, and may be considered highly susceptible.

Dry Root Rot. In 1930, trials of dwarf bean varieties to test their susceptibility to "dry root rot" or "foot rot" (caused by *Fusarium martii* var. *Phaseoli*) suggested that five varieties were somewhat resistant, namely: "Flageolet Victoria" ("Magnum Bonum"), "Early Saxony," "Incomparable," "Flageolet St. Andrew" and "Dwarf Sharpe's Goliath."

Further trials of these varieties were carried out on infected ground in 1931, through the courtesy of Mr. John Hall, junr., of Bretforton. In these trials, the varieties "Early Saxony" and "Early Prolific," the latter of which was used as a control, were decidedly affected. "Sharpe's Goliath" and "Magnum Bonum" resisted foot rot satisfactorily, remaining green after the susceptible varieties had died off. Their resistance is probably due to their thick stems and extensive root systems. "Flageolet St. Andrew" and "Incomparable" also gave fair results, the latter being an especially good market variety in the opinion of local growers.

Anthracnose. Anthracnose (caused by *Colletotrichum Lindemuthianum*) was noted on the pods of the varieties "Black Prince" and "Early Prolific," but was not of any serious importance.

LEEK DISEASES.

White Tip Disease. The causal organism of the "White tip" disease of leeks has now been worked out fully by Foister (2) and is described as a new species, *Phytophthora Porri*.

The disease was found by us at St. George, Bristol, in 1928, and subsequently at Cheltenham in 1929. In 1931, it appeared to a rather serious extent in market gardens at Evesham and was also noticed at Frenchay, near Bristol.

The disease was prevalent during the winter of 1930, infection being general by October.

In 1931, it was observed on September 5th on plants about to be harvested, having apparently appeared on the plants a few days previously.

On winter leeks, it commenced on infected ground at St. George, Bristol, early in November, and became general about the middle of December.

The results of our variety and dusting trial in 1930-31 have been described in a short paper (5). A longitudinal strip of the plot was dusted with a copper-lime dust (dehydrated copper sulphate 20%, and hydrated lime 80%), at the rate of about two ounces per square yard, on October 23, November 26 and December 15. On March 13, counts were made of the markedly diseased plants in the dusted and control strips, with the following results:—

<i>Variety.</i>				<i>No. of Diseased Plants (out of 40 in each case).</i>	
				<i>Dusted.</i>	<i>Control.</i>
1	Sutton's Improved Musselburgh	..	..	1	37
2	Sutton's Royal Favourite	..	..	3	39
3	Sutton's Prizetaker	..	..	4	40
4	Sutton's Acquisition	..	..	1	31
5	Musselburgh	..	..	1	33
6	Dobbie's International	..	..	0	33
7	Johnson's Giant	..	..	0	37
8	The Lyon	..	..	4	40
9	London Flag	..	..	5	34
10	Broad-leaved Flag or London	..	..	1	30
11	Long Mézières	..	..	1	29
12	Poitou, Large Yellow	..	..	2	37
13	Brabant Winter	..	..	3	33
14	Bulgarian Long-stemmed	..	..	2	33
15	Rouen Winter	..	..	2	38
16	Erfurt Winter	..	..	2	38
17	Carentan Giant Winter	..	..	8	20

In localities where the disease has occurred previously, it is recommended, in view of these results, that dustings should be applied at intervals of three or four weeks from October onwards. The disease does not spread extremely rapidly, hence there is a considerable chance of checking it even although it has already appeared on the plants. Dustings are not so necessary in the early spring, as by then slightly attacked plants begin to grow out of the disease. It is probable that Bordeaux mixture would give as efficient control as copper-lime dust.

Further trials have been laid down in the winter of 1931-32 to determine the minimum number of applications of copper-lime dust necessary to give satisfactory control and also the comparative effectiveness of Bordeaux mixture and ammonium polysulphide.

The latter has been stated by Foister to give fairly satisfactory results.

Although none of the varieties included in the trial showed any general resistance to the disease, several individual plants appeared to be somewhat resistant, and a stock of these is being worked up.

Botrytis Disease. What is apparently on occasion a somewhat serious disease of leeks, caused by a species of *Botrytis*, was observed at Offenham, near Evesham, late in November 1931. The leaf spots are at first grey, elongate, somewhat depressed, becoming enlarged into well-defined grey or whitish areas with water-soaked edges. The affected areas may occur either at the tip of the leaf or near the base. In the latter case, the more distal parts in line with the affected area become yellow and shrivel up.

The mouse-coloured conidiophores and conidia of the fungus are produced on both surfaces of the leaf.

The pathogenicity of the fungus has been proved.

Leek Rust (Puccinia Porri). Leek rust has been noticed for several years in plantings at Offenham, near Evesham. In 1931, it was first observed about September 1st and, as the grower in question considered it of some importance, spraying and dusting trials were laid down. The disease was fairly evenly distributed throughout and was present on plants from both local and commercial seed.

A plot was treated with flowers of sulphur on September 9th, 1931, and further plots with Bordeaux mixture, copper-lime dust, and a proprietary sulphur dust on October 9th, 1931.

Observations made on November 6th showed no visible difference between treated and control plots, all the plants having definitely grown away from the disease.

We have not yet observed the teleutospores of this fungus.

LETTUCE DISEASES.

Stem Rot. A stem rot of lettuce prevalent in market gardens in the Bristol district was referred to in last year's report. This disease closely resembles one which occurs in the United States and is caused by *Bacterium vitians*, but no further work has been done on its pathogenicity.

Observations in a market garden area at Fishponds, Bristol, suggest that the variety "MacHattie's Giant" is resistant to the disease. Thus counts of 100 plants each in two different plots of

the same age, and planted out in November, were made on April 13th, 1931, with the following results :—

Plot 1.	MacHattie's Giant	..	30%	diseased plants.
	All the Year Round	..	83%	diseased plants.
Plot 2.	MacHattie's Giant	..	31%	diseased plants.
	All the Year Round	..	90%	diseased plants.

Pleospora Leaf Spot. The leaf spot of lettuces, described in last year's report and in the "Gardeners' Chronicle" (6) and due to *Pleospora herbarum*, has occurred commonly throughout the Province in 1931, but nowhere to such an extent as to warrant control measures.

Ring Spot. With a view to the control of "ring spot" (caused by *Marssonina panattoniana*) trials were laid down on May 8th, 1931, on four plots of the varieties "MacHattie's Giant" (2), "Goliath" and "Stanstead Park." Plots containing 30, 180, 120 and 80 plants respectively, which at that time showed a considerable amount of the disease, were dusted with copper-lime dust, while adjoining plots of the same size were used as controls. Observations on June 16th showed no difference between dusted and control plots, all plants having produced clean heart leaves and grown away satisfactorily from the disease.

Similar trials are being carried out in the winter of 1931-32. In market garden plantings, the disease has been observed to spread outwards from centres in circles of several yards diameter.

On June 1st, 1931, a plot at the Research Station was planted up with lettuce plants already affected with "ring spot," and these were "dug in" early in September. On September 8th, young plants of the varieties "Lees Immense" and "Stanstead Park" were planted out in the plot and also in a neighbouring plot of the same size. By December 8th, the disease had occurred all over the former, but the plants on the latter were free from disease.

DISEASES OF MINT.

Mint Rust (Puccinia Menthae). Previous but unpublished work by Dr. A. Smith has shown that re-infection of mint plants occurs every year from teleutospores and that the mycelium of the fungus does not live permanently in the underground stems, as was previously supposed.

With these considerations in view, a series of greenhouse plots were laid out as follows on January 14th, 1931, with the co-operation of the late Mr. Frank May, Tewkesbury Road, Cheltenham :—

1. Roots trimmed and washed before planting in greenhouse.
2. Ditto. Green sulphur dusted on roots previous to planting.
3. Trimmed and washed. Roots stirred thoroughly in A.P.S. 1-200.
4. Trimmed and washed. Dusted later with flowers of sulphur.

5. Untrimmed, washed and dipped in A.P.S. 1-200.
6. Untrimmed, washed and burnt.
7. Untrimmed, washed, burnt and dipped in A.P.S. 1-200.
8. Untrimmed, burnt. Not washed.
9. Untrimmed, washed.
10. Untrimmed, washed, and green sulphur dusted on roots.
11. Untrimmed, green sulphur dusted on roots. Not washed.
- 12, 13. Controls.
- 14, 15. Beds watered with A.P.S. (1-200) on February 16th, 1931. Growth barely starting. Otherwise untreated.
- 16, 17. Beds watered with A.P.S. (1-200) on February 2nd, 1931, when no growth visible. Otherwise untreated.
18. Control. Untreated.

"Burnt" means that the old tops were burned off outside before the plants were lifted for forcing.

Each greenhouse bed measured 6 x 4 ft.

In the washing process, the roots were first washed in a large tank, and then transferred to a smaller one for rinsing; in both, they were thoroughly stirred with a fork. They were then transferred to the greenhouse, where the trimming and subsequent planting took place.

The following results were apparent on April 1st :—

1.	15	rustcd shoots.	Growth moderate.
2.	1	"	Growth very yellow.
3.	6	"	Growth strong.
4.	2	"	"
5.	6	"	"
6.	6	"	"
7.	8	"	"
8.	12	"	"
9.	3	"	"
10.	3	"	Growth weak, yellow.
11.	7	"	"
12.	26	"	Growth strong.
13.	21	"	" "
14.	17	"	
15.	14	"	
16.	15	"	
17.	7	"	
18.	12	"	

It will be seen that rust infection in all the beds was very slight, hence the experiments are of little significance. There is some evidence, however, that washing the underground stems preparatory to planting is beneficial :—

Beds with washed "roots."	Rusted shoots (1.4.31)
9	50
Beds with unwashed "roots."	
9	121

Sulphur dusts were in every case injurious to the plants, causing dwarfing and chlorosis.

It should also be noted here that early planted beds are usually practically free from rust. This is in accordance with Smith's observation that the majority of infections occur about December, the shoots showing visible signs of infection (by the production of oecidia) in January or February.

DISEASES OF ONIONS.

Botrytis Disease. This disease of spring onions was first noticed at Offenham, near Evesham, on November 26th, 1931, and was subsequently observed in market gardens near Bristol. The symptoms are suggestive of frost injury and have been described as such on several occasions. The lesions first appear as small circular or elliptic white spots, often surrounded by water-soaked margins. The area surrounding the spots may eventually dry out and become yellowish-green or grey, so that the tips of the leaves die off. The younger leaves of the plants are less affected than the old.

The disease is apparently very dependent on temperature and humidity. It may cause loss both by checking the growth of the plants and by rendering the onions unsightly when they are bunched for the market.

The organism in question is a small sclerotial *Botrytis* and has been proved to be highly pathogenic to onions.

PARSNIP DISEASES.

Parsnip "Canker." Further work has convinced us that practically all, if not all, of the so-called parsnip "canker" occurring in the Bristol Province is primarily due to injury by dipterous larvae, possibly carrot fly larvae. It was found in a variety trial, carried out through the courtesy of Mr. Walter Byrd, at Norton, near Evesham, that certain varieties tended to split badly at the crowns. This was especially the case in badly shaped varieties. Fungus infection following this type of injury, however, was of little importance compared to infection following carrot fly injury. Three varieties out of 20 included in the trial were of excellent shape with practically no splitting.

Sclerotinia Rot. Stored parsnip roots severely affected with the fungus *Sclerotinia Sclerotiorum* were received from a seedsman in Evesham. The specimens had been forwarded to him from the eastern counties.

DISEASES OF PEAS.

Foot Rots. In the course of our survey of pea fields in the Evesham area in 1931, it was found that in many cases, in addition

to the foot rot caused by *Fusarium martii* var. *Pisi*, previously recorded, the roots of the plants were attacked by the eelworm *Heterodera Schachtii*. This infestation was reported by us in the "Gardeners' Chronicle" (7) and has been recorded by Miss M. J. Triffitt in the "Journal of Helminthology" (9).

Severe infestations were observed also at Hallow, near Worcester, and at Berkeley, Glos.

The affected plants, when severely attacked, were much dwarfed, rather pale in colour, and tended to die off at an early stage.

The varieties most severely affected were "Pilot," "Early Bird," "Laxton's Progress," "Laxton's Superb," "Admiral Beatty," and "British Lion," and it will be noticed that these varieties were amongst those listed as most susceptible to *Fusarium* foot rot in last year's report. It is important to observe also that the early varieties are those most severely affected. This is also the case in "potato sickness," caused by *Heterodera Schachtii* in association with certain fungi.

The relationship between the *Heterodera* and the fungus has yet to be determined. Plants have frequently been found with *Fusarium* lesions only, but in this case the plants are not so markedly dwarfed as when *Heterodera* is also present. On the other hand, apparently healthy plants have been found, the roots of which were covered with eelworm cysts. Other plants, markedly diseased, and bearing eelworms on the roots, gave no *Fusarium* but in its place *Thielavia basicola*.

As in the case of "potato sickness," various anomalies have been noticed. Thus good results have sometimes been observed following treatment of the ground with dung, while in other cases such treatment has given poor results in comparison with other fertilisers.

In 1932, in addition to greenhouse experiments, it is proposed to lay down a comprehensive manurial trial on an infected plot while at the same time further variety trials are to be carried out.

Leaf and Pod Spots. Considerable detailed work has been carried out on the leaf and pod spots and foot rots caused by species of *Ascochyta*. It has been found that both *Ascochyta Pisi* and *Mycosphaerella pinodes* are prevalent in the Province, the former bringing about an important spotting of the pods and the latter, in addition, a severe foot rot.

Both these organisms have been found to be carried in the seed. It appears from our pot experiments that both are susceptible to control by certain seed dressings and field trials are to be laid down in 1932.

Mosaic Disease. A mosaic disease of peas was found in our plantings at the Research Station, occurring at the rate of about 1% on plants from commercial samples. There was no evidence of its spread. The leaves and stipules were strikingly mottled with pale green or with yellowish-green depressed or raised areas, usually between the veins. The pods were markedly distorted, with irregular, somewhat linear depressed dark green areas. The stems were also mottled. Preliminary experiments indicate that the disease is transmissible by rubbing.

POTATO DISEASES.

Potato "Sickness." In 1930, treatment of a small plot of ground affected with potato "sickness" appeared to give some control. A larger plot was laid down in 1931 on infected ground at Bristol Mental Institute, Fishponds, through the kindness of the Director and Mr. J. Merrick, head gardener. The rows, previously dug to the depth of 6 ins., were watered thoroughly with 1 in 50 formalin at the rate of 11 gallons per row of 7 yds. ($4\frac{1}{2}$ gallons per square yard). The rows were then covered in and left for ten days before planting. The variety in question was "Great Scot." The results were as follows:—

					<i>Yield.</i>
Plot 1.	Check.	Untreated.	4 rows ..	..	20 lb.
2.	4 treated rows (20 plants per row)			..	70 lb.
3.	Check.	Untreated.	4 rows ..	..	27 lb.

DISEASES OF VEGETABLE MARROW.

Mosaic. Our further work on mosaic of vegetable marrow will not be discussed here in detail as a comprehensive paper is in preparation. Our results to date show that the disease may spread rapidly throughout the season, the insect vector being probably the aphid *Macrosiphum gei*. Certain aspects of the problem are being investigated by Dr. Kenneth M. Smith, of Cambridge.

It has not been found possible to transmit the disease from likely wild plants such as White Bryony, nettles or docks.

No evidence of seed transmission is as yet forthcoming.

REFERENCES.

- (1) BARKER, B. T. P., and GIMMINGHAM, C. T. "Experiments on the Treatment of *Rhizoctonia* Disease of Asparagus." *Ann. Rept. Agr. and Hort. Res. Stn., Long Ashton, Bristol*, 1916, p. 39; and "Further experiments on the *Rhizoctonia* Disease of Asparagus." *Ibid.*, 1917, p. 28.
- (2) FOISTER, C. E. "The White Tip Disease of Leeks and its Causal Fungus, *Phytophthora Porri* n. sp." *Trans. and Proc. Bot. Soc. Edinburgh*, 30, Pt. 4, pp. 257-281.

- (3) OGILVIE, L. "Observations on the Diseases of Market Garden Crops in the Vale of Evesham." *Ann. Rept. Agr. and Hort. Res. Stn., Long Ashton, Bristol*, for 1929, pp. 149-154, 1930.
- (4) OGILVIE, L. and MULLIGAN, B. O. "Progress Report on Vegetable Diseases." *Ann. Rept. Agr. and Hort. Res. Stn., Long Ashton, Bristol*, for 1930, pp. 127-146, 1931.
- (5) OGILVIE, L. and MULLIGAN, B. O. "White Tip Disease of Leeks." *Gard. Chron.*, 89, No. 2315, p. 360, May 9, 1931.
- (6) OGILVIE, L. and MULLIGAN, B. O. "A Leaf Spot of Lettuce due to *Pleospora herbarum*." *Gard. Chron.*, 89, No. 2298, p. 35, January 10, 1931.
- (7) OGILVIE, L. and MULLIGAN, B. O. "Pea Sickness, an important Disease of Field Peas." *Gard. Chron.*, 90, No. 2328, p. 122, August 8, 1931.
- (8) SALMON, E. S., and WARE, W. M. "Root Rot of Asparagus." *Gard. Chron.*, 87, No. 2258, p. 275, April 5, 1930.
- (9) TRIFFITT, M. J. "On the Eelworm *Heterodera Schachtii* attacking Peas in Britain." *Journ. Helminth.*, 9, No. 3, pp. 175-178, July, 1931.

PLATE I.

"Halo Blight" of Dwarf Beans (caused by *Bacterium Medicaginis* var. *phaseolicola* Burk.). Typical "halo" leaf spots.

PLATE II.

"Halo Blight" of Dwarf Beans.

- FIG. 1. Stem of infected plant, showing bacterial exudates.
- FIG. 2. Wilt effect, produced by inoculation of the stem with a pure culture a fortnight previously.
- FIG. 3. Pods B. inoculated with bacterial culture, pod S. pricked with sterile needle. Photograph taken nine days subsequently.
- FIG. 4. Affected Pods. Natural infections.

NOTES ON THE RUSTS OF BASKET WILLOWS AND THEIR CONTROL.

BY LAWRENCE OGILVIE.

The willows grown commercially for basket-making in Somerset are mainly of two species, *Salix triandra* and *Salix viminalis* (the osier willow). These are attacked by distinct species of rust fungi, neither of which have up to now been positively identified. The object of the present paper is to describe these diseases in popular terms and to suggest means for their control. A detailed account of investigations on these rusts will be published elsewhere.

1. *The Rust on Salix triandra.*

The young shoots of *Salix triandra* appear from the old stumps during April. Within about a fortnight of their emergence, there may be seen, especially near the base of the young stems and on the oldest and lowest leaves, elongated, bright orange cankers or swellings. (Fig. 1.) These bear, after the lapse of a week or so, minute flask shaped bodies containing chains of spores, the so-called oecidia, the first stage in the life history of the rust.

The original infections which gave rise to these oecidial cankers took place as the green shoots were first emerging from the stumps, minute spores, the so-called sporidia, having been shot off from another stage of the fungus which overwinters on the dead leaves, as will be described later.

The oecidial stage is of brief duration but is of great importance, as it instigates the prevalent summer or uredo stage. Oecidio-spores alighting on the opening leaves of the young shoots bring about infections which give rise to bright orange pustules on the lower, or more rarely on the upper surfaces, and cause, in severe cases, distortion, considerable leaf fall and stunting of the growth of the plant.

The spread of the uredo stage takes place with great rapidity since, under favourable conditions, *i.e.* warm and moist weather, the production of fresh pustules takes place as soon as five days after infection.

The most important stage in the life history of the rust, from the grower's point of view, is the infection of the green stem itself.

This first takes place early in July and usually occurs in the neighbourhood of an infected leaf stalk. These infections do not extend greatly in area but, with the enlargement and hardening of the stem, elongated and depressed cankers are formed. These cankers continue to produce orange coloured uredospores throughout the summer as do the uredo pustules on the leaves.

The uredo stage is succeeded, first of all on the lower leaves, by the teleuto or resting pustules, which begin to appear early in July and are produced continuously till the time of leaf-fall. (Fig. 4.) These form dark brown crusts which are confined mainly to the lower surfaces of the leaves and are composed of thick walled spores closely packed together in a palisade-like layer. These spores persist throughout the winter. No germination takes place till early April when, during a very limited period when the young willow shoots are first appearing, each spore gives rise to four minute sporidia which are shot off and bring about the oecidial infections again, thus initiating the yearly cycle.

The uredo stem cankers already referred to persist throughout the winter in a dormant state and in early spring produce a fresh crop of uredospores. On rods in pits, uredospores may appear as early as March. The cankers produce the well-known black marks on the peeled rods, caused by the bark adhering to the wood at these points. (Fig. 2.) These constitute the chief damage done to the industry by the rust, since affected rods are disfigured and break easily.

It will be observed that initiation of the yearly cycle may be brought about either by sporidia shot off from the old leaves on the ground (giving rise to oecidia, the oecidio-spores from which again give rise to uredo pustules), or by uredospores liberated from over-wintered cankers on old rods. The latter method has been found to be very unusual, since the old rods are cut off in winter or early spring almost level with the ground, leaving the stump clean. Occasionally, however, the stump may be infected, especially if the withies have not been cut off sufficiently low down, and the resulting cankers may continue to bear uredospores, every spring, year after year. (Fig. 3.) In fields where there appears to be little infection from dead leaves, the removal of such infected stumps may prove to be of considerable importance in the control of the disease.

As already stated, the fungus does not extend beyond the area covered by the cankers on the rods, hence cankered rods may be safely used as sets if the cankered parts are cut off.

Infection experiments and measurements of the fungus (to be

described more fully elsewhere) have established its identity with *Melampsora Amygdalinae*, first described by H. Klebahn from Germany in 1899, but apparently not previously recorded from this country.

It is important from the practical point of view that this rust is entirely confined to *Salix triandra* and does not produce an alternate stage on any other plant, as many of the willow rusts do.

Attempts to infect leaves of the common tree willows *Salix alba* and *S. fragilis* with uredospores of this rust were unsuccessful, as was to be expected from Klebahn's previous work.

With regard to the control of the disease, there are five possible lines of approach :—

1. *Applications of fungicides.* It would seem from the life history of the rust that the period during which fungicides are most likely to be successful is when the young shoots first appear in the spring, and that *it is of the first importance to prevent the initial infection by the sporidia.* That such infection can be prevented under controlled conditions is shown by the following greenhouse experiment. On April 10th, 1931, dead leaves bearing teleutospores were suspended at the top of an inverted beaker over four willow plants (*S. triandra* var. "Champion Rod") grown from cuttings, three of which had been sprayed with Bordeaux mixture (5-5-50). On April 24th, the leaves of the unsprayed plant showed oecidial cankers while the other three plants remained free from rust.

In an endeavour to control the disease in the field, a trial plot was sprayed with Bordeaux mixture (5-5-50) on April 9th, 1931, at Midelney Farm, Drayton, near Langport, through the courtesy of Mr. Abel Willey. The withies in question, *S. triandra* var. "Black Maul," had been cut from the stumps in December and the largest buds at the time of spraying were $\frac{1}{2}$ in. long.

Counts of oecidial infections on sprayed and unsprayed plots on May 19th showed no significant difference between the two, thus ten sprayed stumps had 17 infections while ten unsprayed showed 22 infections.

Again, a series of plots of the same variety in another field were dusted with ground sulphur and copper lime dust on April 23rd, 1931, and on the following subsequent dates, May 25th, June 27th and July 14th. The plots in question were in a spot which had shown severe rust infection in the previous year. Each plot consisted of four rows and contained about 500 plants. The dusted plots were separated by undusted. The largest shoots measured about an inch in length when the first dusting took place.

Counts were made of uredinial cankers on 100 rods in the middle of dusted and undusted plots on November 12th, 1931, with the following results :—

1.	Copper lime dust	..	..	..	75 cankers.
2.	Check	..	..	..	183 cankers.
3.	Copper lime dust	..	..	..	73 cankers.
4.	Check	..	..	..	182 cankers.
5.	Ground sulphur	..	..	..	92 cankers.
6.	Ground sulphur	..	..	..	95 cankers.

It will be seen that the dusted rows in both cases had approximately half the number of cankers of the check rows. The amount of control, however, was not regarded as sufficient to warrant the application of the dusts, although it must be remembered that the plots were sufficiently narrow to allow reinfection of dusted rows to take place from control rows.

It is recognised that the disease is extremely difficult to control once it has gained impetus owing to the quick growth of the shoots and the rapid multiplication of the uredinial pustules. It is suggested that *the most important applications are the earliest, and that the first spray or dust should be put on when the buds first begin to show green, followed by a second about a week later.*

2. *Late Cutting of Rods.* It is the general experience amongst growers that stumps from which withies are cut in spring produce shoots free from basal cankers and are therefore more liable to remain comparatively free from rust. This is apparently because the young shoots have not appeared during the time when the sporidia are shot off.

3. *Removal of Infected Stumps.* In fields where little oecidial infection takes place and where uredinial infection still appears, it would probably pay the grower to go round in early spring and remove stumps showing uredinial cankers.

4. *Drainage.* Observations indicate that initial oecidial infections are prevalent in certain spots year after year, usually hollows where water tends to collect and where washings of dead leaves tend to accumulate. It is suggested that such areas should either be drained by ditches giving a fairly rapid run off or, if this is not possible, that the stumps should be grubbed up. Otherwise they tend to be centres of serious initial infection.

5. *Resistant Varieties.* The possibility of raising varieties resistant to rust must always be borne in mind. The following varieties have been infected from uredo material from "Black Maul" by careful inoculations in the laboratory: "Stone Rod," "Light French," "Notts Spaniard," "Mottled Spaniard," "Black Spaniard," "Glibskin," "White Newkind," "Seedling Newkind,"



FIG. 1.



FIG. 2.

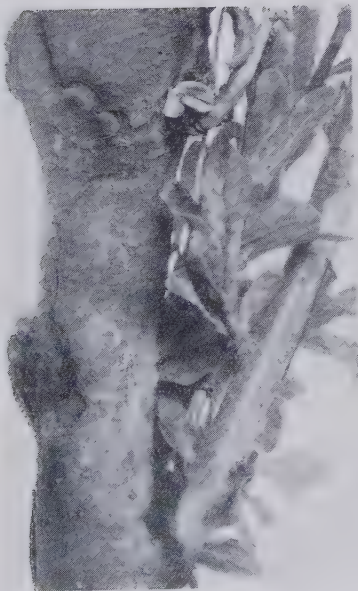


FIG. 3.



FIG. 4.

“Whissender,” “Grizette Noire,” “Champion,” and “Black German.” It should be noted, however, that there are possibly several strains of *Melampsora Amygdalinae* on *Salix triandra*. Thus uredospores taken from a stem canker on “Champion Rod” produced infection on “Newkind Spaniard” and on “Champion Rod” but not on “Jacob’s triandra” under the same conditions, although “Jacob’s triandra” is infected with the rust in the field.

According to growers, the variety “Black Spaniard” is somewhat resistant, while “Champion Rod” is highly susceptible.

2. *The Rust on Salix viminalis.*

The minute yellow uredo-pustules of this rust appear mainly on the under surfaces of the leaves from June until the time of leaf-fall.

From early August onwards teleuto-pustules are produced, intermingled with the uredo-pustules. The former are found on both leaf surfaces and take the form of small, raised, pale brown blisters or extensive crusts, which are composed of prismatic, thick walled cells, the teleutospores.

The teleutospores germinate in early spring, giving rise to thin walled sporidia which have been shown experimentally to infect leaves of the common larch (*Larix europaea*).

About a fortnight after infection, minute pale orange oecidial pustules are produced on the larch leaves. They appear to be formed out of doors in May and June, the resulting oecidiospores in turn infecting young leaves of *Salix viminalis*, on which uredospores are again produced.

The rust does not form cankers on the willow stems and the only method of over-wintering appears to be by means of teleutospores on dead leaves.

The rust has been identified as *Melampsora Larici-epitea*, first described by Klebahn. It is not of great economic importance. Although severe uredo infections may take place, it is seldom that severe defoliation follows. Sometimes a severe development of teleuto-pustules may follow an apparently slight uredo infection. In this case, the leaves become very much blackened and leaf-fall may take place. The lateness of these infections, however, renders the effect on the rods practically negligible, hence control measures are unnecessary.

The writer wishes to express his indebtedness to Professor H. Klebahn, Dr. E. J. Butler, Dr. G. H. Pethybridge, Mr. W. B. Grove and Dr. Alex Smith for their assistance in the matter of literature dealing with the fungi concerned and to Mr. H. P. Hutchinson, Willow Officer, for suggestions.

ILLUSTRATIONS.

Melampsora Amygdalinæ.

FIG. 1.—Cutting of *Salix triandra* var. "Champion Rod" grown in a pot in a cool greenhouse. On April 10th, 1931, dead leaves bearing teleutospores were suspended over the plant inside a beaker. The photograph was taken on April 29th and shows a typical oecidial canker which has developed at the base of one of the young shoots.

FIG. 2.—Uredinial cankers on peeled rods.

FIG. 3.—Old stump of *Salix triandra* var. "Black Maul" showing persistent uredinial stem canker, producing uredospores. From willow fields at Athelney, March 18th, 1931.

FIG. 4.—Teleutosori on leaves of *Salix triandra* var. "Black Maul."

OBSERVATIONS ON HOP DISEASES IN HEREFORDSHIRE AND WORCESTERSHIRE WITH SUGGESTIONS FOR THEIR CONTROL.

BY LAWRENCE OGILVIE.

DOWNY MILDEW.

The year 1931 has demonstrated conclusively the seriousness of Downy Mildew to hop-growers in the Western Counties and has emphasised the importance of preventive measures. Up to this year, it had been supposed that the climatic conditions prevalent in the West, particularly the low night temperatures, and the fact that the variety "Fuggles," formerly regarded as resistant, was the one most commonly cultivated, would prevent the disease from reaching such epidemic proportions as it had done in the East.

Observations made in previous years by Mr. Goaman, formerly Ministry's Inspector for Herefordshire, by Mr. C. L. Pearson, the present Inspector, and by the writer had made clear the widespread occurrence of the disease. In the spring of both 1929 and 1930, "spiked" shoots were found in practically every yard, however remote, scattered rather sporadically, but more prevalent where the yards were in low lying or poorly drained situations. Where no attempt was made to reduce the amount of infection by the removal of spiked shoots from year to year, there was an undoubted increase in the amount of disease. In several cases this led to the grubbing of whole yards.

In the course of last season, even after the spiked shoots and later the lower leaves of the bines had been removed—measures which in previous years had been sufficient to keep the disease in check—the disease continued to spread to the upper leaves. It was then realised by several growers that spraying was necessary if the cones were to be adequately protected. The most disastrous period was the third week in August when practically continuous rain caused a wholesale infection of the burr. The most severe infection throughout was on "Goldings" but, although the bines of "Fuggles" remained comparatively free, there was also a heavy infection of "Fuggles" cones when these were adjacent to other varieties.

Through the cordial co-operation of the Worcestershire and Herefordshire Hop Growers' Association, the Ministry's Inspector for the area, Mr. C. L. Pearson, and the Hereford County Horticultural Adviser, Mr. C. Savidge, a scheme has been formulated for assisting growers in the diagnosis of this and other hop diseases in 1932. Growers who are in difficulties should communicate with any of these authorities. There will be periodic surveys of the area and growers will be assured of having the best advice possible. At the same time, research will be carried out at Long Ashton on aspects of hop diseases which are peculiar to the area or which are not receiving attention by Professor Salmon at Wye College.

The routine recommendations for the control of Downy Mildew are as follows :—

Basal Spikes should be removed as soon as they are noticed in the spring and should either be placed in a container and burned, or dipped in a disinfectant solution. If the disease is present, the lower leaves of the bines should be stripped as soon as it is possible to do so. The bines should then be sprayed at frequent intervals throughout the summer with Bordeaux mixture (5-5-50, or, if hydrated lime is used, 5-7½-50). In Kent the following sprayings have been recommended : (1) when the bines are three quarters up the strings* ; (2) when they have reached the top ; (3) just before the plants come into "burr" ; (4) immediately after the "burr" has gone. Last season, healthy crops were obtained even when the first spraying had been omitted.

As a result of the experiences of Kent growers, Salmon (2) now recommends the use of a fairly heavy spray for the two last sprayings, as much as 300 to 350 gallons per acre. A "Burgess" blower is now generally employed attached to an ordinary hop-washer, a number of coarse discs being used. In the case of the first application, the spray should be put on as a fine mist at the rate of not more than 150 gallons per acre.

If copper lime dust is used, at least 50 per cent. more applications appear to be required.

NETTLEHEAD.

This disease is characterised by shoots which are somewhat pale in colour, and which bear leaves which tend to be folded inwards and upwards. There is usually an abnormal production of side shoots and the bines tend to come off the strings. Plants infected

*Salmon in his latest publication (*Jour. S.E. Agr. Coll., Wye, No. 28, p. 52, 1931*) recommends the omission of this first spraying.

in previous years become greatly dwarfed, do not climb, and the tips of the shoots may die off. It was formerly thought that the symptoms were caused by the attack of the eelworm *Heterodera Schachtii* on the roots, but this view has been discredited, and Professor Salmon has recently shown that it can be transmitted by grafting. It therefore probably belongs to the class of "virus diseases" and is very possibly transmitted by an insect.

Field observations in Worcestershire indicate that it very commonly commences at a headland. Its spread is often in a circle, the rate of spread being four or five plants per year. Spread takes place as easily across the rows as up and down and several cases have been noted of a slantwise spread across the yard. The direction of spread is usually that of the prevailing wind. In other cases spread is more sporadic.

No case of recovery has been observed; hence affected plants should be grubbed up. The disease can be eliminated only by persistent and intelligent grubbing. The grower should remove four or five healthy plants beyond those which show the symptoms, as the symptoms may not become apparent during the current year. Again, roguing is probably more effective in spring than later on.

Nettlehead is confined mainly to the variety "Fuggles," but it has also been found on "Early Bird," "Mathon" and "Bramling."

Attempts have been made by the writer to transmit the disease by means of the common hop aphid *Phorodon humuli*, but without success. The so-called "Kaderavost," "Kräuselkrankheit," or "curl" disease of hops in Czecho-Slovakia, which has been investigated by Blattny, (1) has many points in common with nettlehead. It has been shown by Blattny to be transmitted by the leaf-hopper *Empoasca (Chlorita) flavescens*, and experiments are being carried out by the writer with this insect, which occurs commonly in hedgerows in the area.

SPLIT LEAF.

This disease is also mainly confined to "Fuggles." It is apparently of little importance in Kent, but seems to be spreading in the Western Counties. The symptoms are well known to growers. The bases of many of the leaves are split up as if they had been eaten by an insect. This condition is brought about by an abnormal thinness of the affected part of the leaf at an early stage in its growth. Affected plants tend to throw an abnormal number of side shoots and the yield of cones is poor.

The disease spreads in the same way as nettlehead throughout the yards, and seems likely also to prove to be a virus disease. The plants appear to recover somewhat towards the end of the growing period, but apparently never recover completely.

The trouble can be kept down only by persistent roguing.

CHLOROTIC DISEASE.

This disease was first reported from a hop-yard near Tenbury, and was found in 1931 in three or four widely separated yards in Worcestershire. The symptoms are a curling down of the outer lobes of the leaves, accompanied by patches of pale yellow, giving the leaves a curious "parrot's beak" appearance. In severe cases the bines may be greatly dwarfed.

Professor Salmon and W. M. Ware have studied this disease (3) and have shown that it is highly infectious by grafting. The spread of the disease in the field resembles that of nettlehead and split leaf. Since it is apparently a disease of considerable importance, all affected plants along with several neighbouring healthy ones should be grubbed up immediately from yards in which they occur.

MOSAIC DISEASE.

In the case of mosaic disease, the edges of the leaves are curled downwards in balloon-like fashion and are noticeably brittle. There is also some mottling. The disease is also transmissible by grafting and is of the same nature as the three foregoing diseases. "Fuggles" is apparently immune. As in the case of the above diseases, control can be achieved only by thorough and persistent roguing.

REFERENCES.

- (1) BLATTNY, C. "Studies on the 'Kaderavost' Disease of the Hop." *Receuil de Trav. des Inst. des Recherches Agron. de la Republique Tchecoslovaque*, Prague, 56 : 44 pp., 1930.
- (2) SALMON, E. S. Address at Hop Growers' Conference, S.E. Agr. Coll., Wye, Jan. 13th, 1932.
- (3) SALMON, E. S. and WARE, W. M. "The Chlorotic Disease of the Hop." *Ann. Appl. Biol.* 17, pp. 241-247, 1930.

CIDER MAKING TRIALS FOR THE SEASON 1930-31.

BY O. GROVE.

The 1930 cider apple crop was below the average in most districts, both in quantity and quality. In some parts of Hereford and Monmouth the crop was, however, fairly good. The juices were characterised by exceptionally low sugar contents, the average specific gravity of juices from all the samples examined at the Institute being only 1.0469. This is the lowest average but one ever recorded at the Institute, and is a remarkable contrast with that for the previous season, 1929, which was 1.0575, the highest but one recorded. The highest and lowest gravities hitherto recorded were 1.060 and 1.046, these occurring in the years 1921 and 1922 respectively. There are thus two outstanding cases of a year of exceptionally high gravities being followed immediately by a year of abnormally low gravities. It would seem likely that the heavy drain in the carbohydrate reserves of the trees resulting from the production of a crop of fruit very rich in sugar is not fully replaced during the growing period of the following summer and that, accordingly, the succeeding crop is deficient in that respect. It is noteworthy that in spite of this deficiency of sugar in the juices, the ciders as a whole turned out to be of very fair quality, being agreeable in flavour even if on the light side. The season afforded a very good illustration of the point that the specific gravities of the juices alone do not provide a reliable guide to the quality of the ciders made from them. There was a fair crop of perry pears.

THE CIDER AND PERRY COMPETITIONS.

For the sixth year in succession, a competition on similar lines to those described in earlier reports was arranged.

102 entries of fruit were received. Of these 91 were apples and 11 pears. The fruit was stored until fit for milling, and the subsequent treatment given to each cider and perry was uniform except for the following differences as to the filtration period. In Classes I, II and VI the ciders and perries were filtered when the specific gravity of the fermenting juices was 1.030 ; in Classes III and IV, 1.025 was the filtration gravity.

The competition was open to growers residing in the counties of Devon, Dorset, Gloucester, Hereford, Monmouth, Somerset and Worcester. The entries from the different counties were distributed as follows:—Devon, 22; Dorset, 2; Gloucester, 16; Hereford, 18; Monmouth, 27; Somerset, 15; Worcester, 2.

The ciders and perries were judged on April 28th and 29th, 1931, by Messrs. G. A. Martin, Bristol; E. G. F. Walker, Chew Stoke, Bristol; and the Hon. J. W. Best, Melplash, Dorset.

Class I (Kingston Black), with only two entries, was disappointing, the quality of the ciders being much below the usual standard of this variety.

Class II (Sharp Varieties) was, as last year, divided into two groups:—A, with an acidity of the juices of 0.80% or above; B, with an acidity below 0.80%. Group A comprised ciders which can only be used for blending with ciders of lower acidity, whereas the ciders in Group B can be used unblended. Group A (13 entries), contained some good ciders with a very pronounced acid flavour, but not much “body.” Nos. 1 and 2 had a clean, sharp character. Of the Fredericks, No. 5 was considered the best in spite of the exceptionally low specific gravity of the juice—all the samples of this variety had an abnormal deposit of pectic substances, which was precipitated soon after filtration. No. 10, Red Streak, was a good sharp cider, better than No. 11, Bastard Tom Putt, which had little character. No. 13, Somerset Crab, was a very sharp cider of moderate value. The two last of the group, Cap of Liberty and Hartisman, were good samples. Group B (15 entries), was a good class with a fair range of acidity. Most of the ciders could be used alone or for blending. The best in the group were Dymock Red, Crimson King, White Sharp, Kempley Red and Colmans. The last variety was tried for the first time. No. 28, Cowarne Red, was below the usual standard for the variety. The rest of the entries in the group were quite fair ciders.

Class III (Sweet Varieties) with 29 entries was not of high merit. The ciders were rather thin and lacking in body, without the characteristic aroma of a sweet class. No. 25, Tale Sweet, was considered the best sample in the group. As this apple was making its appearance in the trials for the first time, it may prove a very useful addition to the rather limited group of first-class sweet cider apples. The six samples of Perthyres were very similar in character, rather thin ciders of fair quality: No. 38 was the best of the lot. The samples of Sweet Alford and Woodbine sent in produced ciders much below the best standard of the varieties. Slack-ma-Girdle was the best of the remainder of the varieties entered.

Class IV (Bittersweet Varieties) with 19 entries was a better class than could have been expected for the season. The ciders were well balanced, the bitter flavour not being too prominent. No. 61, White Norman, was one of the best of the group, a most useful cider for blending with ciders made from sharper varieties. No. 63, Cummy Norman, was similar in character. Of the Strawberry Normans, No. 72 was superior to the others. No. 65, Sweet Buckland, tried for the first time, gave a good cider of a mild bittersweet character. No. 66, Tremlett's Bitter, was a fair cider with some astringency. No. 67, Knotted Kernel, gave a cider of high quality. Royal Wilding, No. 74, was a good representative of this variety. The rest of the entries were of quite fair quality, the four last of the class being somewhat inferior to the others.

Class V, for Blends (13 entries), was an excellent class, all of the samples being of high quality. As explained below in the judges report, the samples were made up by blending individual exhibitor's ciders entered in the sharp class and either or both of the sweet and bittersweet classes in proportions determined by the Institute, as stated in the table. As will be seen from the table, two blends, A and B, were made from each set of ciders by blending the individual ciders in different proportions, the A blends being slightly more acid than the B blends.

The Blends, Nos. 79, 80, 86, 87 and 88, were similar in character, and they all had the variety Frederick as the sharp component. These blends clearly demonstrated the excellent quality of this variety for blending purposes. Both the No. 81 blends were of good quality, the A blend being considered the better of the two. The same was found in the case of No. 82, where the B blend was a little too bitter. Otherwise the lower acidity (B) blends were preferable to the higher acidity (A) blends in nearly all cases. The No. 83 blends, consisting of four varieties, were very similar and both good ciders. In the cases of Nos. 84 and 85, the B blends were the best, the same being found with No. 89, whereas No. 90 A was superior to No. 90 B. Blend No. 91, although containing Kingston Black cider, was not considered up to the standard of some of the Frederick blends.

Class VI, Perries (11 entries), was not of such good quality as in the two previous seasons, but the Blakeney perries were considered good for this variety, especially the two first, Nos. 92 and 93. No. 97, a variety tried for the first time, gave a perry of moderate quality. No. 98, Oldfield, was superior to the rest, as is usual with this excellent variety. The Clarets produced very acceptable perries, No. 100 being the better of the two. The Butt perries were

not quite so astringent in flavour as usual, and No. 102 was a very fair sample of the variety.

With regard to the samples Nos. 103-111 from the Long Ashton Trial Orchard, they were on the whole below standard, because of the low specific gravity of the juices characteristic of the season.

REPORT OF JUDGES ON THE LONG ASHTON CIDER COMPETITIONS 1930-31.

The judging of the ciders in these Competitions took place on April 28th and 29th, 1931.

Before dealing with the individual classes, a few general comments on the ciders may be made. Throughout all classes, the effect of the abnormally poor quality of the 1930 crop of fruit was obvious. The average specific gravity of the freshly expressed juices was the lowest recorded in the history of these competitions. There was therefore a general deficiency in body and alcoholic strength in nearly all the ciders: consequently, they were exceptionally light drinks. The acidity was generally slightly lower than usual, but stood out with unusual prominence on the palate in view of the thin character of the beverages in the classes for sharp varieties in particular. Apart from this feature, the flavour generally was pleasant, although thin. There was a noteworthy absence of taints in every case, a remarkable result in such a season and one reflecting great credit on the cider house staff. Moreover, in no instance was there a single cider which could not be converted into a palatable beverage after suitable blending.

Only two entries were submitted in Class I for Kingston Black apples only. This was due to the failure of the crop of this variety in 1930. Only one prize has been recommended, the award going to a cider of fair quality, but lacking in body. The standard was decidedly below the average for this famous apple.

Following on the satisfactory results obtained last year by dividing the Class for Sharp Apples into two sections—A for very acid sorts suitable only for blending, and B for medium acid sorts suitable for use unblended—this class was treated similarly on this occasion. Both sections were good as a whole in spite of the penetrating character of the acidity and general lack of body. The Frederick ciders showed an abnormal pectin deposit, attributable to the effect of the season on the fruit. There were 13 entries in Section A of this class and 15 in Section B.

Class III, for Sweet Varieties, with 29 entries, maintained its usual reputation as a somewhat disappointing class. The ciders were rather thin, featureless and lacking in body, although clean in flavour. No entry was of distinctive merit.

The Bittersweet Class (Class IV) contained 19 entries. For the season it was a good class with a well-balanced proportion of bitterness. The unpleasantly marked astringency noted in some years was absent on this occasion. For blending purposes, the material was very useful.

The Blend Class (Class V) was this year treated on new lines. Instead of growers entering a mixture of apples made up by themselves in proportions selected by them as suitable to yield a good blend, the blending was done by the Institute. Each grower making entries in the sharp class, and either or both of the sweet and bitter-sweet classes, was entitled to have those entries also included in the class for blends. Two types of blends, differing slightly in acidity were made up in each case and, as far as possible, a uniform standard was aimed at throughout for each type. The result was an excellent class of ciders, all of them of bottling quality. Every one was adjudged as being of high merit. Incidentally, the value of Frederick as a sharp apple for blending has been clearly shown on this occasion. In this form, the class represents a new departure of high educational and commercial value, and demonstrates what can be done in the way of producing a set of well-balanced and uniform ciders from material of the most varied description. It is hoped that the class will be continued in future years in this form.

The Perry Class (Class VI) contained 11 entries. Compared with the exceptionally high quality of this class in the two previous years, the standard this time was moderate. The Blakeney Red perries as a whole were good for this variety. The general level of the class was certainly affected by the lack of entries of the Oldfield variety, of which there was only one, and that secured the first prize.

In conclusion, we must not omit a reference to the obvious care with which the whole of the work entailed has been conducted, and the impartial effort made to give all entries an equal chance in these competitions, which by their nature must be exceptionally difficult to manage in this respect.

Signed G. A. MARTIN.

JAMES W. BEST.

ELDRED G. F. WALKER.

Judges.

TABLE I.
COMPETITION VARIETIES.

No.	Name of Variety.	Date of making.	Specific Gravity of		Tannin per cent.	Rate of Fermentation.	Date of Filtering.	Specific Gravity of		Name and Address of Grower.
			Fresh Juice.	Malic Acid per cent.				at time of May, 1931.	Filtering.	
CLASS 1.—KINGSTON BLACKS—										
1	Kingston Black ..	17/11/30	1.047	0.46	0.12	7.1	5/12/30	1.030	1.026	G. Williams & Son, Westhild, Her.
2	" ..	17/11/30	1.051	0.47	0.14	4.2	22/1/31	1.030	1.029	Stead Bros., Penhow Castle, Newport, Mon.
CLASS 2A.—SHARP VARIETIES. Acidity 0.8 per cent. or above.—										
3	Red Streak ..	14/10/30	1.047	1.14	0.09	6.4	22/10/30	1.030	1.028	P. E. Bomford, Cowsden Hall, Wor.
4	King of the Orchard	24/10/30	1.048	0.83	0.12	6.0	6/11/30	1.030	1.029	S. J. Mullins, Dingestow, Mon.
5	Frederick ..	28/10/30	1.038	0.90	0.07	5.4	3/11/30	1.030	1.028	S. W. Mullins, Raglan, Mon.
6	Frederick ..	28/10/30	1.041	0.97	0.09	4.8	5/11/30	1.030	1.028	S. J. Mullins, Dingestow, Mon.
7	Frederick ..	28/10/30	1.046	1.07	0.09	3.8	27/11/30	1.030	1.030	W. Beer, Abergavenny, Mon.
8	Frederick ..	28/10/30	1.046	1.12	0.09	3.6	5/12/30	1.030	1.030	J. P. Williams, Abergavenny, Mon.
9	Frederick ..	28/10/30	1.050	1.08	0.09	3.6	17/12/30	1.030	1.029	W. P. Martell, Usk, Mon.
10	Red Streak ..	28/10/30	1.048	1.15	0.09	7.4	5/11/30	1.030	1.030	H. Knight, Huntley, Glou.
11	Bastard Tom Putt	3/11/30	1.049	0.83	0.17	3.2	20/11/30	1.030	1.030	W. H. Hunt, Easton-in-Gordano, Som.
12	Frederick ..	4/11/30	1.048	1.03	0.09	3.5	16/12/30	1.030	1.030	G. Breakwell, Rockfield, Mon.
13	Somerset Crab ..	12/11/30	1.045	1.10	0.21	5.2	1/12/30	1.030	1.029	E. C. Smith, Stoke Abbott, Dorset.
14	Cap of Liberty ..	17/11/30	1.053	0.89	0.18	5.2	19/1/31	1.030	1.030	J. T. Shield, Berkeley, Glou.
15	Hartsman ..	1/12/30	1.043	0.80	0.16	4.6	15/12/30	1.030	1.028	W. H. Hunt, Easton-in-Gordano, Som.
CLASS 2B.—MEDIUM SHARP VARIETIES. Acidity below 0.8 per cent.										
16	White Sharp ..	30/10/30	1.043	0.58	0.12	4.0	18/11/30	1.030	1.030	W. H. Hunt, Easton-in-Gordano, Som.
17	Fair Maid of Devon	30/10/30	1.043	0.76	0.10	5.2	7/11/30	1.030	1.028	J. Walters & Sons, Newton St. Cyres, Devon.
18	American Norman	31/10/30	1.048	0.46	0.24	6.7	7/11/30	1.030	1.030	R. Evans, Norton Canon, Her.

TABLE I.—*continued.*

CIDERS.

COMPETITION VARIETIES.

CLASS 2B.—MEDIUM SHARP VARIETIES. Acidity below 0.8 per cent.— <i>could.</i>									
19	Greasy Red Streak	4/11/30	1.048	0.78	0.14	4.6	22/11/30	1.030	G. E. Puddy, Wrington, Som.
20	Tom Putt	4/11/30	1.046	0.64	0.15	6.1	18/11/30	1.030	H. R. Jenkins, Westhild, Her.
21	Royal Somerset	4/11/30	1.046	0.71	0.11	5.6	20/11/30	1.030	E. Down, Pinhoe, Devon.
22	Tom Putt	4/11/30	1.047	0.61	0.12	7.8	17/11/30	1.030	J. Taylor, Much Marcle, Her.
23	Crimson King	4/11/30	1.049	0.53	0.12	6.5	20/11/30	1.030	E. C. Smith, Stoke Abbott, Dorset.
24	Golden Streak	4/11/30	1.053	0.77	0.08	7.1	22/11/30	1.030	G. E. Puddy, Wrington, Som.
25	Dymock Road	7/11/30	1.048	0.54	0.19	4.0	5/12/30	1.030	E. T. Lewis, Dymock, Glos.
26	Ponsford	12/11/30	1.045	0.66	0.13	5.0	2/12/30	1.030	F. E. Salter, Crediton, Devon.
27	Kempey Red	12/11/30	1.040	0.45	0.13	4.2	3/12/30	1.030	W. Wootton, Ryford, Her.
28	Cowarne Red	17/11/30	1.048	0.73	0.11	5.5	10/1/31	1.030	W. P. Merrett, Arlington, Glos.
29	Colmans	18/11/30	1.044	0.75	0.15	5.0	24/12/30	1.030	J. Walters & Sons, Newton St. Cyres, Devon.
30	Wyatt's Seedling	20/11/30	1.045	0.44	0.14	4.0	8/12/30	1.030	W. J. Berry, Newton St. Cyres, Devon.
CLASS 3.—SWEET VARIETIES—									
31	Sweet Alford	24/10/30	1.046	0.36	0.15	5.7	3/11/30	1.025	J. Peck, Ottery St. Mary, Devon.
32	Golden Ball	24/10/30	1.044	0.31	0.15	3.2	13/12/30	1.025	S. W. Mullins, Raglan, Mon.
33	Belle Norman	30/10/30	1.043	0.27	0.18	5.0	17/11/30	1.025	J. E. Bradley, The Newbolds, Mon.
34	Perthyres	30/10/30	1.045	0.25	0.18	5.2	17/11/30	1.025	S. W. Jones, Fregare, Mon.
35	Perthyres	30/10/30	1.043	0.23	0.17	4.2	24/11/30	1.025	W. Beer, Abergavenny, Mon.
36	Perthyres	30/10/30	1.045	0.24	0.17	4.5	22/11/30	1.025	S. J. Mullins, Dingestow, Mon.
37	Perthyres	30/10/30	1.044	0.25	0.17	3.0	15/12/30	1.025	A. L. Thomas, Manson, Mon.
38	Perthyres	30/10/30	1.046	0.27	0.18	3.5	29/11/30	1.025	W. P. Marfell, Langeview, Usk, Mon.
39	Sweet Alford	30/10/30	1.049	0.22	0.15	2.7	17/1/31	1.025	F. Vincent, Pinhoe, Devon.
40	Sweet Alford	30/10/30	1.050	0.24	0.14	2.5	26/1/31	1.025	S. Cursons, Dunsford, Devon.
41	Sweet Alford	3/11/30	1.049	0.20	0.15	2.2	27/1/31	1.025	E. Down, Pinhoe, Devon.
42	Perthyres	4/11/30	1.047	0.28	0.16	6.1	24/11/30	1.025	H. R. Jenkins, Westhild, Her.
43	Pound Apple	4/11/30	1.054	0.29	0.16	6.1	2/12/30	1.025	F. Vincent, Pinhoe, Devon.
44	Slack-ma-Girdle	7/11/30	1.047	0.28	0.12	4.2	16/12/30	1.025	S. Cursons, Dunsford, Devon.
45	Sweet Alford	7/11/30	1.048	0.20	0.12	2.4	5/3/31	1.025	H. Hoare, Staverton, Devon.

TABLE I.—*continued*.

CIDERS.

COMPETITION VARIETIES.

No.	Name of Variety.	Date of making.	Specific Gravity of Fresh Juice.	Malic Acid per cent.	Tannin per cent.	Rate of Fermentation.	Date of Filtering.	Specific Gravity at time of May, 1931.	Name and Address of Grower.	
CLASS 3.—SWEET VARIETIES— <i>contd.</i>										
46	Berkeley Pippin	7/11/30	1.045	0.24	0.14	7.6	24/11/30	1.025	1.024	W. H. Hunt, Easton-in-Gordano, Som.
47	Red Norman	7/11/30	1.042	0.22	0.18	5.6	25/11/30	1.025	1.023	R. T. Hinckes, Foxley, Her.
48	Sweet Alford	12/11/30	1.050	0.22	0.12	4.2	16/1/31	1.025	1.024	H. J. Phelps, Tibberton, Glos.
49	Perthyles	12/11/30	1.043	0.30	0.17	5.2	8/12/30	1.025	1.024	G. Breakwell, Rockfield, Mon.
50	Woodbine	13/11/30	1.055	0.40	0.16	5.7	18/12/30	1.025	1.025	W. Hill, Kittisford, Som.
51	Woodbine	13/11/30	1.044	0.26	0.13	4.7	19/12/30	1.025	1.023	J. Walters & Sons, Newton St. Cyres, Devon
52	Woodbine	13/11/30	1.050	0.27	0.12	4.5	31/12/30	1.025	1.024	R. J. Denning, Ilminster, Som.
53	Woodbine	13/11/30	1.049	0.29	0.12	5.2	23/2/31	1.025	1.025	F. E. Hosegood & Son, Ilminster, Som.
54	Sweet Alford	13/11/30	1.046	0.20	0.13	3.2	15/1/31	1.025	1.025	G. E. Puddy, Wington, Som.
55	Tale Sweet	17/11/30	1.057	0.31	0.16	4.5	23/2/31	1.025	1.025	H. Daniel, Honiton, Devon.
56	Pear Pine	17/11/30	1.044	0.22	0.11	6.2	9/12/30	1.025	1.024	A. J. Abbott, Ivybridge, Devon.
57	Pound Apple	18/11/30	1.050	0.39	0.17	5.3	2/1/31	1.025	1.025	G. W. Voysey, Musbury, Devon.
58	Perthyles	20/11/30	1.044	0.27	0.19	5.8	5/12/30	1.025	1.023	S. W. Mullins, Raglan, Mon.
59	Woodbine	26/11/30	1.047	0.22	0.16	4.4	24/12/30	1.025	1.026	J. H. Chapman, Ilminster, Som.
CLASS 4.—BITTERSWEET VARIETIES—										
60	Royal George	14/10/30	1.052	0.36	0.22	5.8	10/11/30	1.025	1.024	W. H. Hunt, Easton-in-Gordano, Som.
61	White Norman	21/10/30	1.055	0.27	0.34	6.0	17/11/30	1.025	1.023	W. R. Thomas, Nunnington, Her.
62	Large Hangdown	24/10/30	1.044	0.23	0.22	3.7	24/11/30	1.025	1.025	R. Collins, Chagford, Devon.
63	Cummy Norman	31/10/30	1.053	0.30	0.27	7.5	17/11/30	1.025	1.021	R. Evans, Norton Canon, Her.
64	Strawberry Norman	31/10/30	1.051	0.34	0.34	8.2	13/11/30	1.025	1.023	"
65	Sweet Buckland	3/11/30	1.051	0.27	0.20	5.8	28/11/30	1.025	1.024	A. Dibble, Ilminster, Som.
66	Tremlett's Bitter	3/11/30	1.048	0.22	0.26	2.8	30/12/30	1.025	1.025	F. Vincent, Pinhoe, Devon.

TABLE I.—continued.

CIDERS.

COMPETITION VARIETIES.

CLASS 4.—BITTERSWEET VARIETIES—*contd.*

67	Knotted Kernel..	4/11/30	1.060	0.38	0.28	4.3	5/2/31	1.025	1.023	J. E. Edwards, Norton Canon, Her.
68	Royal Wilding ..	7/11/30	1.051	0.25	0.22	7.6	2/12/30	1.025	1.023	R. C. G. Cotterell, Bridge Sollers, Her.
69	Bittersweet ..	12/11/30	1.049	0.35	0.22	4.2	12/1/31	1.025	1.025	G. W. Voysey, Musbury, Devon.
70	Strawberry Norman	12/11/30	1.050	0.36	0.34	4.7	29/12/30	1.025	1.023	E. T. Lewis, Dymock, Glos.
71	Brown Shout ..	12/11/30	1.051	0.26	0.23	4.5	22/1/31	1.025	1.025	" "
72	Strawberry Norman	13/11/30	1.055	0.34	0.32	5.0	22/1/31	1.025	1.024	J. Lloyd, Newent, Glos.
73	Strawberry Norman	17/11/30	1.049	0.24	0.31	4.7	13/1/31	1.025	1.023	G. H. Chudley, Ipplepen, Devon.
74	Royal Wilding ..	17/11/30	1.050	0.24	0.19	7.0	16/12/30	1.025	1.019	G. Williams & Son, Westhilde, Her.
75	French ..	20/11/30	1.046	0.26	0.34	5.8	10/12/30	1.025	1.023	W. Beer, Abergavenny, Mon.
76	French ..	20/11/30	1.054	0.30	0.46	5.8	27/12/30	1.025	1.021	A. L. Thomas, Manson, Mon.
77	French ..	20/11/30	1.051	0.34	0.36	7.0	8/12/30	1.025	1.021	I. R. Price, Westhilde, Her.
78	Councillor ..	20/11/30	1.051	0.16	0.31	6.8	13/12/30	1.025	1.022	T. Fawkes, Leonard Stanley, Glos.

CLASS 5.—BLENDS MADE FROM CIDERS ENTERED IN CLASS 1 OR 2; CLASS 3 AND 4. A and B indicate two different blends of the same ciders in proportions as shown. The numbers in brackets are the programme numbers of the ciders used for the blend.

79A	Frederick (7)—1, Perthyres (35)—1, French (75)—1 ..	..	..	0.59	0.16	..	..	..	1.025	W. Beer, Abergavenny, Mon.
79B	Frederick (7)—2, Perthyres (35)—5, French (75)—3 ..	..	..	0.52	0.19	..	..	..	1.025	W. Beer, Abergavenny, Mon.
80A	Frederick (12)—1, Perthyres (49)—2 ..	..	..	0.60	0.17	..	..	..	1.027	G. Breakwell, Rockfield, Mon.
80B	Frederick (12)—1, Perthyres (49)—4 ..	..	..	0.53	0.15	..	..	..	1.026	G. Breakwell, Rockfield, Mon.
81A	Royal Somerset (21) —3, Sweet Alford (41)—2 ..	..	..	0.57	0.12	..	..	..	1.028	E. Down, Pinhoe, Devon.
81B	Royal Somerset (21) —1, Sweet Alford (41)—1 ..	..	..	0.54	0.12	..	..	..	1.027	E. Down, Pinhoe, Devon.

TABLE I.—*continued*.
COMPETITION VARIETIES.

No. Name of Variety.	Date of making.	Specific Gravity of Fresh Juice.	Malic Acid per cent.	Tannin per cent.	Rate of Fermen- tation.	Date of Filtering.	Specific Gravity at time of May, Filtering. 1931.	Name and Address of Grower.
CLASS 5.—BLENDS MADE FROM CIDERS ENTERED IN CLASS 1 OR 2; CLASS 3 AND 4, ETC.— <i>contd.</i>								
82A American Norman (18)—8, Cummy Norman (63)—1, Strawberry Nor- man (64)—1 ..	..	..	0.42	0.22	..	..	..	1.028 R. Evans, Norton Canon, Her.
82B American Norman (18)—4, Cummy Norman (63)—1, Strawberry Nor- man (64)—1 ..	..	..	0.40	0.28	..	..	..	1.027 R. Evans, Norton Canon, Her.
83A Hartisman (15)—1, Royal George (60)—1, White Sharp (16)—1, Berkeley Pippin (46)—1 ..	..	..	0.54	0.14	..	..	..	1.026 W. H. Hunt, Easton-in-Gordano, Som.
83 B Hartisman (15)—1, Royal George (60)—2, White Sharp (16)—2, Berkeley Pippin (46)—1 ..	..	..	0.52	0.14	..	..	..	1.025 W. H. Hunt, Easton-in-Gordano, Som.
84A Tom Putt (20)—3, Perthryres (42)—2	..	..	0.58	0.16	..	..	..	1.027 H. R. Jenkins, Westhide, Her.
84B Tom Putt (20)—1, Perthryres (42)—2	..	..	0.48	0.14	..	..	..	1.026 H. R. Jenkins, Westhide, Her.

TABLE I.—*continued.*

CIDERS.		COMPETITION VARIETIES.				CLASS 5.—BLENDS MADE FROM CIDERS ENTERED IN CLASS 1 OR 2; CLASS 3 AND 4, ETC.— <i>contd.</i>	
85A	Dymock Red (25)— 12, Strawberry Nor- man (70)—1, Brown Snout (71)—6 ..	..	0.56	0.20	..	..	1.026 E. T. Lewis, Dymock, Glos.
85B	Dymock Red (25)— 4, Strawberry Nor- man (70)—1, Brown Snout (71)—4 ..	..	0.51	0.22	..	..	1.026 E. T. Lewis, Dymock, Glos.
86A	Frederick (9)—1, Perthyres (38)—2	..	0.60	0.15	..	..	1.026 W. P. Marfell, Usk, Mon.
86B	Frederick (9)—1, Perthyres (38)—3	..	0.50	0.16	..	..	1.025 W. P. Marfell, Usk, Mon.
87A	Frederick (6)—1, Perthyres (36)—4, King of the Or- chard (4)—1 ..	..	0.55	0.14	..	..	1.026 S. J. Mullins, Dingestow, Mon.
87B	Frederick (6)—1, Perthyres (36)—6, King of the Or- chard (4)—1 ..	..	0.47	0.15	..	..	1.026 S. J. Mullins, Dingestow, Mon.
88A	Frederick (5)—1, Perthyres (58)—2, Golden Ball (32) —1 ..	..	0.53	0.15	..	..	1.025 S. W. Mullins, Raglan, Mon.
88B	Frederick (5)—1, Perthyres (58)—1, Golden Ball (32) —4 ..	..	0.51	0.15	..	..	1.024 S. W. Mullins, Raglan, Mon.

TABLE I.—*continued.*

CIDERS.		COMPETITION VARIETIES.						
No. Name of Variety.	Date of making.	Specific Gravity of Fresh Juice.	Malic Acid per cent.	Tannin per cent.	Rate of Fermentation.	Date of Filtering.	Specific Gravity at time of May, Filtering, 1931.	Name and Address of Grower.
CLASS 5.—BLENDS MADE FROM CIDERS ENTERED IN CLASS 1 OR 2; CLASS 3 AND 4, ETC.— <i>contd.</i>								
89A Greasy Red Streak (19)—1, Golden Streak (24)—1, Sweet Alford (54)—2	..	..	0.57	0.13	..	..	..	1.027 G. E. Puddy, Wrington, Som.
89B Greasy Red Streak (19)—1, Golden Streak (24)—1, Sweet Alford (54)—4	..	..	0.50	0.12	..	..	..	1.026 G. E. Puddy, Wrington, Som.
90A Fair Maid of Devon (17)—1, Colmans (29)—1, Woodbine (51)—2	..	..	0.59	0.11	..	..	..	1.025 J. Walters & Sons, Newton St. Cyres, Devon.
90B Fair Maid of Devon (17)—1, Colmans (29)—1, Woodbine (51)—4	..	..	0.53	0.13	..	..	..	1.025 J. Walters & Sons, Newton St. Cyres, Devon.
91A Kingston Black (1)—1, Royal Wilding (74)—2	..	..	0.47	0.19	..	..	..	1.023 G. Williams & Son, Westhide, Her.
91B Kingston Black (1)—2, Royal Wilding (74)—5	..	..	0.46	0.17	..	..	..	1.022 G. Williams & Son, Westhide, Her.

TABLE I.—*continued*.

PERRIES.

COMPETITION VARIETIES.

No. Name of Variety.	Date of making.	Specific Gravity of Fresh Juice.		Tannin per cent.	Rate of Fermentation.	Date of Filtering.	Specific Gravity at time of May, Filtering, 1931.		Name and Address of Grower.
		of	Fresh				of	May,	
CLASS 6.—PERRIES—									
92 Blakeney Red ..	14/10/30	1.043	0.45	0.08	5.8	21/10/30	1.030	1.025.	S. Mills, Dunley, Wor.
93 Blakeney Red ..	22/10/30	1.043	0.51	0.13	4.2	3/11/30	1.030	1.030	S. J. Mullins, Dingestow, Mon.
94 Blakeney Red ..	22/10/30	1.040	0.43	0.12	2.0	14/11/30	1.030	1.029	A. L. Thomas, Manson, Mon.
95 Blakeney Red ..	22/10/30	1.051	0.44	0.15	3.2	18/12/30	1.030	1.030	J. Lloyd, Newent, Glos.
96 Blakeney Red ..	28/10/30	1.051	0.54	0.09	4.0	2/12/30	1.030	1.030	H. Knight, Huntley, Glos.
97 Newbolds Pear ..	28/10/30	1.056	0.62	0.08	5.6	14/11/30	1.030	1.028	J. E. Bradley, The Newbolds, Mon.
98 Oldfield ..	13/11/30	1.049	0.56	0.10	6.7	2/12/30	1.030	1.025	G. Williams & Son, Westhide, Her.
99 Claret ..	26/11/30	1.049	0.44	0.11	5.2	13/12/30	1.030	1.029	T. Fawkes, Leonard Stanley, Glos.
100 Claret ..	26/11/30	1.050	0.47	0.10	4.6	19/12/30	1.030	1.030	C. G. Ricketts, Dymock, Glos.
101 Butt ..	26/11/30	1.054	0.47	0.23	1.4	30/3/31	1.030	1.030	W. P. Merrett, Arlingham, Glos.
102 Butt ..	26/11/30	1.053	0.50	0.25	1.8	26/1/31	1.030	1.030	A. J. Cook, Norton, Glos.
CIDERS AND PERRIES MADE FROM THE LONG ASHTON TRIAL CIDER ORCHARD.									
103 Cap of Liberty ..	17/11/30	1.042	0.87	0.20	4.3	23/12/30	..	1.029	Long Ashton Trial Orchard.
104 Kingston Black ..	17/11/30	1.048	0.57	0.16	4.6	2/1/31	..	1.029	..
105 Lambrook Pippin	27/11/30	1.042	0.65	0.21	4.2	16/12/30	..	1.027	..
106 Sweet Alford ..	5/11/30	1.041	0.29	0.13	4.6	13/11/30	..	1.020	..
107 White Alphonington	17/10/30	1.041	0.31	0.14	3.2	30/10/30	..	1.027	..
108 Knotted Kernel	5/11/30	1.047	0.23	0.36	5.1	1/12/30	..	1.026	..
109 Dabinett ..	27/11/30	1.052	0.23	0.29	5.7	29/12/30	..	1.018	..
110 Claret Pear ..	20/11/30	1.042	0.42	0.09	4.8	2/12/30	..	1.029	..
111 Pint Pear ..	20/11/30	1.043	0.38	0.10	4.2	2/11/30	..	1.027	..

TABLE II.
COMPETITION CIDERS AND PERRIES, 1930-31.

JUDGES' AWARDS.

CIDERS.

<i>Class 1.</i>	<i>No.</i>	KINGSTON BLACK. (2 <i>Entries</i>).	
First Prize ..	2	Stead Brothers, Penhow Castle, Newport.	
<i>Class 2A.</i>		SHARP VARIETIES. (Acidity 0.8% or above). (13 <i>Entries</i>).	
			<i>Variety.</i>
First Prize ..	5	S. W. Mullins, Raglan, Mon...	Frederick.
Second Prize ..	15	W. H. Hunt, Easton-in-Gordano, Som. . . .	Hartisman.
Third Prize ..	14	J. T. Shield, Berkeley, Glos...	Cap of Liberty.
Fourth Prize ..	10	H. Knight, Huntley, Glos. . .	Red Streak.
Reserve Prize ..	9	W. P. Marfell, Llangeview, Usk, Mon. . . .	Frederick.
<i>Class 2B.</i>		MEDIUM SHARP VARIETIES. (Acidity below 0.8%) (15 <i>Entries</i>).	
First Prize ..	25	E. T. Lewis, Dymock, Glos.	Dymock Red.
Second Prize ..	23	E. C. Smith, Stoke Abbott, Dorset	Crimson King.
Third Prize ..	16	W. H. Hunt, Easton-in-Gordano, Som. . . .	White Sharp.
Fourth Prize ..	27	W. Wootton, Byford, Hereford	Kempley Red.
Reserve Prize ..	20	H. R. Jenkins, Westhidge, Hereford	Tom Putt.
Highly Commended	29	J. Walters & Sons, Newton St. Cyres, Devon	Colmans.
<i>Class 3.</i>		SWEET VARIETIES. (29 <i>Entries</i>).	
First Prize ..	55	H. Daniel, Honiton, Devon..	Tale Sweet.
Second Prize ..	38	W. P. Marfell, Llangeview, Usk, Mon. . . .	Perthyres.
Third Prize ..	52	R. J. Denning, Ilminster, Som.	Woodbine.
Fourth Prize ..	41	E. Down, Pinhoe, Devon . .	Sweet Alford.
Reserve Prize ..	44	S. Cursons, Dunsford, Devon	Slack-ma-girdle.
Highly Commended	51	J. Walters & Sons, Newton St. Cyres, Devon	Woodbine.
<i>Class 4.</i>		BITTERSWEET VARIETIES. (19 <i>Entries</i>).	
First Prize ..	67	J. E. Edwards, Norton Canon, Hereford	Knotted Kernel.
Second Prize ..	61	W. R. Thomas, Nunnington, Hereford	White Norman.
Third Prize ..	72	J. Lloyd, Newent, Glos. . .	Strawberry Norman.
Fourth Prize ..	74	G. Williams & Son, Westhidge, Hereford	Royal Wilding.
Reserve Prize ..	65	A. Dibble, Ilminster, Som. . .	Sweet Buckland.
Highly Commended	63	R. Evans, Norton Canon, Hereford	Cummy Norman.

Class 5.

BLENDS. (26 Entries).

First Prize	..	87B	S. J. Mullins, Dingestow, Mon.	
Second Prize	..	79B	W. Beer, Abergavenny, Mon.	
Third Prize	..	86B	W. P. Marfell, Llangeview, Usk, Mon.	
Fourth Prize	..	89B	G. E. Puddy, Wrinton, Som.	
Fifth Prize	..	85B	E. T. Lewis, Dymock, Glos.	
Sixth Prize	..	81A	E. Down, Pinhoe, Devon.	
Reserve Prize	..	82A	R. Evans, Norton Canon, Hereford.	
Highly Commended		79A	W. Beer, Abergavenny, Mon.	
"	"	82B	R. Evans, Norton Canon, Hereford.	
"	"	83A	W. H. Hunt, Easton-in-Gordano, Som.	
"	"	83B	W. H. Hunt, Easton-in-Gordano, Som.	
"	"	84B	H. R. Jenkins, Westhidge, Hereford.	
"	"	86A	W. P. Marfell, Llangeview, Usk, Mon.	
"	"	90A	J. Walters & Son, Newton St. Cyres, Devon.	

Class 6.

PERRIES. (11 Entries).

Variety.

First Prize	..	98	G. Williams & Son, Westhidge, Hereford	Oldfield.
Second Prize	..	100	C. G. Ricketts, Dymock, Glos.	Claret.
Third Prize	..	92	S. Mills, Dunley, Worcs.	Blakeney Red.
Fourth Prize	..	102	A. J. Cook, Norton, Glos.	Butt.
Reserve Prize	..	93	S. J. Mullins, Dingestow, Mon.	Blakeney Red.

THE IMPROVEMENT OF FARM-MADE CIDER.

BY P. T. H. PICKFORD.

Since the Bath and West Society started its first experiments on cider-making at Butleigh Court, Somerset, with the object of effecting an improvement in the standard of cider as commonly made on the farms at that time, there has gradually developed a remarkable change in the position of cider as a beverage in this country. Instead of being a drink mainly confined to the cider making counties in the West of England,—and there largely restricted to the consumers in the country districts on the farms and in the villages,—it has now come into far more general favour and is a popular drink throughout the British Isles.

This article is not concerned with the causes of this change, but the subject with which it deals is a direct outcome of the effects on the cider industry from the farmer's point of view.

There has arisen a growing demand for a high quality cider by the general public to whom cider as a palatable beverage was formerly almost unknown.

The increasing number of people who have recently adopted cider as a daily beverage are not, however, content with the type of cider which passes under the name of "farmhouse" cider—generally a type which is completely "dry" and more or less acetified. The demand now is for a more refined sweet or medium sweet cider with a slightly brisk flavour and free from any taint of acetification. A cider of this type now has a market value much higher than the rough "farmhouse" product.

While a limited number of farmers who have kept abreast of modern methods of cider-making and have specialised in producing the type of beverage now popular have profited as a result, the factory-made article has held by far the greatest share of the market. The average farmer who still continues to make cider in preference to selling his apples to the factories has been gradually forced into a difficult position. The old practice of supplying cider to the farm labourers is rapidly dying out, the former outlet for the surplus—the local public houses—is being closed to a large extent owing to the breweries tying their houses to cider supplied by themselves, and "farmhouse" cider commands little sale in other

directions. Consequently, during the last few years, there has been general concern among farmer cider-makers to produce a more marketable article.

THE PROVISION OF LOCAL INSTRUCTION IN CIDER-MAKING.

To meet the case, the Agricultural Education Departments of the counties concerned have extended their activities in the direction of cider-making instruction. Some have provided their own instructors on orcharding and cider-making, who have kept in close touch with Long Ashton. Three counties—Dorset, Monmouth, and Worcester—decided to participate in a conjoint scheme administered direct from Long Ashton. This scheme came into operation in 1926, and an account of the work in connection therewith is the main purpose of this article. An endeavour will be made at the same time to indicate in outline the methods of cider-making commonly found practised, and the directions in which they can be readily modified to render them capable of yielding a product suited for the present-day market.

The Cider Instruction Scheme which involves the counties of Dorset, Monmouth and Worcester was commenced in 1926 with the objects of improving the standard of cider-making on the farm and of assisting and encouraging the farmer to produce a more palatable type of cider as a profitable branch of the farming industry.

It is organised from the National Fruit and Cider Institute, Long Ashton, where the Instructor has his headquarters and is able to keep in close touch with the current research on the subject there. From this centre, the Instructor visits the respective counties in turn, providing the farmer with individual assistance and keeping him in touch with the most up-to-date methods of cider-making.

In the early stages of the work, when a general survey of the cider districts was made, a definite conclusion was reached regarding the farmer and the cider industry. It was evident that unless the farmer improved the standard of his cider and his methods of making, the market for his cider would be lost. It was also clear that, unless he was prepared to give more care and attention to cider-making, it would be more profitable for him to sell his apples. The tying of local public houses to factory cider was already taking place in many districts, and was seriously interfering with the disposal of draught cider made on the farm. As the bottling trade was developing—and this is by far the most profitable line—the farmer-maker was encouraged to produce this type.

Following this general survey of the districts, the Instructor commenced his work in the autumn of 1926 by arranging demonstration lectures at various centres in each county, giving the farmers

an outline of modern cider-making methods. These were then followed up by paying individual visits to the farmers, giving them advice and assistance to meet their particular problems.

In the first year of the scheme, several farmers in each county placed themselves almost entirely in the hands of the Instructor. After an examination of their available apples, a suitable blend was advised, and the cider was made strictly under the Instructor's supervision. Frequent visits followed during the fermenting period when personal instruction was given regarding the control of fermentation. These were supplemented by later visits at which filtration and other methods of arresting fermentation, storage, bottling and other post-fermentation matters were dealt with.

The following particulars will give some indication of the extent of the work.

The number of visits paid to farmers was as follows :—

			DORSET.	MONMOUTH.	WORCESTER.	TOTAL.
1926-27	..	..	72	78	81	231
1927-28	..	..	80	79	87	246
1928-29	..	..	131	84	96	301
1929-30	..	..	113	92	97	302
1930-31	..	..	109	101	104	314

Demonstration lectures on cider-making have been given on farms as follows :—

1926-27.	DORSET	..	Stoke Abbott (25), Storridge (12), Waytown, Netherbury (15).
	MONMOUTH	..	Usk (24), Bishton (13), Rockfield (12), Abergavenny (10), Rhiwderin (10).
	WORCESTER	..	Corse Lawn (11), Bushley (12), Newnham (15).
1927-28.	DORSET	..	Melplash (9), Netherbury (12), Stoke Abbott (15).
	MONMOUTH	..	Raglan (14), Mathern (10), Mitchel Troy (16), Llangattock (30).
	WORCESTER	..	Corse Lawn (16), Tenbury (11).
1928-29.	DORSET	..	Chideock (22), Blandford (10).
	MONMOUTH	..	Usk (27), Nantyduerry (10), Skenfrith (6).
	WORCESTER	..	Welland (11), Newnham (16).
1929-30.	DORSET	..	Hamoon (17).
	MONMOUTH	..	Llantrisant, Usk (22).
	WORCESTER	..	Great Whitley (19).
1930-31.	DORSET	..	Puddletrenthide (24).
	MONMOUTH	..	Llanarth (14), Hendre (17), Llanvapley (25).

(The numbers in brackets show the attendances at the respective demonstrations).

Demonstrations on the filtering of cider have been given at the following centres :—

1928-29.	DORSET	..	Bridport, Blandford, Farrington, Wimborne.
	MONMOUTH	..	Rhiwderin, Twyn-y-Sheriff, Nantyduerry, Llan-tilio, Mitchell Troy, Court Perrot.

1929-30.	DORSET	..	Netherbury, Eype, Puddletrenthide, Melplash, Gillingham, Farrington.
	MONMOUTH	..	Caerleon, Rhiwderin, Rockfield, Tredunnoc, Raglan, Llantilio.
	WORCESTER	..	Great Whitley, Cotheridge.
1930-31.	DORSET	..	Shillingstone, Blandford, Milton, Broadoak, Bridport.
	MONMOUTH	..	Caerleon, Llanvair, Llantilio, Llanvetherine, Llangattock, Dingestow, Pentwyn.
	WORCESTER	..	Lyppard.

Although, at the commencement of the work, it was found that the art of cider-making was, on the whole, more advanced in Worcester than in Dorset and Monmouth, satisfactory progress was soon made in the two latter counties.

In Dorset, a keen interest was taken and a Federation of Farm Cider-Makers was instituted through a local branch of the Farmers' Union. The main object of the Federation has been to encourage a high standard of quality in the cider produced by its members. It has been invaluable by way of procuring the National Mark for its members, who do not produce a large enough quantity of cider to enable them to obtain the Mark individually.

The cider produced in this county was found to be of the low acid type, and a great deal of time has had to be spent on eliminating the risk of such disorders as "sickness" and "ropiness" by careful selection of varieties and by judicious blending.

In Monmouth, where a wider area has had to be covered, advancement has been more gradual, but ample material for the production of good cider was found. The filtering demonstrations were greatly assisted in this county when a filter for this purpose was procured by the Farm Institute at Usk.

The system of cider-making in Monmouth by means of the travelling mill is still in vogue. A disadvantage of this system is the difficulty which is so often experienced of obtaining the mill at the right time. With the installation of an up-to-date cider-making plant at the Usk Farm Institute, it will now be possible, however, to assist farmers in that district by milling and pressing their fruit at this centre and giving them the best return possible. The installation of the plant will also make it possible for the students there to get an insight into modern methods of cider-making.

In Worcester, where cider-making is generally practised on more scientific lines, problems of a more advanced nature have been dealt with. Work on such problems as the controlling of the deposit in

bottled cider has been taken up to some extent, and experiments on disgorging and pasteurising bottled cider have been undertaken.

New interest has been taken in cider-making in the commercial fruit-growing districts in the county. In these localities, where increasing quantities of "cull" fruit have become available for cider, the problems of judicious blending of varieties and of the addition of vintage apples necessary to produce a reasonably good beverage, are growing acute.

A SURVEY OF FARM CIDER-MAKING PRACTICE.

Passing on to the matters of detail in cider-making which were found in the course of the work to require special attention, lack of knowledge on two points of fundamental importance, (a) the quality and appropriate mode of use of the varieties of apples, and (b) the control of fermentation, immediately showed itself as the chief general reason for the failure to produce cider suited for modern requirements.

Apple Varieties and their Uses. It was found that in many districts little was really known of the value of the individual varieties of cider apples. Although hundreds of varieties have been tested at the Cider Institute from time to time, yet numerous local, unknown varieties were encountered in the older orchards, and had to be examined in order to obtain some idea of proportioning them for blending suitably.

Where sufficient quantities of unknown varieties were available, it was possible to send them to the Cider Institute for trial in the annual Cider Competitions there; but, where the quantities were only small, some knowledge of their value was obtained from the analysis of the juice expressed from small samples.

A large number of more or less inferior varieties were found, and the farmers were advised to adopt the system of keeping them separate for "haymaking" cider, and concentrating on the best sorts only for the best cider.

The selection of the fruit is the primary factor governing the quality of the cider. Too often it was found that the practice was merely to express the juice from all the available apples on the farm together indiscriminately, despite their varying stages of ripeness, and with no thought of mixing them in a manner to balance the qualities of the various types.

The classes of apples had to be studied to enable the farmer to discriminate between sharp, sweet and bittersweet varieties. Here the taste of the apple was found adequate as a simple and useful guide.

Where sufficiently large quantities of single varieties were available, the best results were obtained by storing them separately and making them up separately, subsequently blending the ciders after fermentation; but, in the majority of cases, the farmer had not sufficient quantity of any single variety to enable him to do this, and he had to rely on mixing his apples according to their season of ripeness—sharp, sweet and bittersweet varieties in suitable proportions. The type of cider desired by the consumer and the varying sharpness or bitterness of the varieties must determine the exact proportions: but as a general guide had to be given, the suggested proportion was from one to two parts of sharp fruit, one part of sweet and one part of bittersweet fruit, as constituting a fairly widely approved mixture, giving a juice of an acidity about 0.5 per cent., and from 0.15 per cent. to 0.2 per cent. of tannin.

It was pointed out to the farmer how the quality of the cider is determined to a large extent by the vintage quality of the fruit. In selecting varieties when planting young trees or when head-working older trees, the farmer has been recommended to insist on having only varieties which have now been proved capable of producing cider of the highest grade and the trees of which are strong, clean and healthy.

Very useful information regarding the growth and suitability of particular varieties in their respective districts can now be obtained from the Trial Cider Orchards, which have been distributed over the cider districts of the West of England for this purpose.

Fermentation Control. The control of the fermentation was found to be the chief problem connected with cider-making on the farm. The aim was to produce a reasonably sweet cider for bottling.

Racking, combined with sulphuring, was demonstrated to a great extent and was found to be beneficial up to a point. In a few cases where the cider fermented slowly, this was sufficient to arrest the fermentation at the point where the required amount of sugar was left in the juice, but, on the whole, it was found that the results were too precarious, and such methods could not be relied on.

It soon became apparent that a filtering machine was essential to farmers in the regular production of a sweet cider suitable for bottling.

The next step, therefore, was to demonstrate the filtration of cider on the farm. A filter was lent by the Cider Institute for this purpose. The machine was taken to the farm when the cider had reached the required gravity, and the method of filtration was then demonstrated to the farmer. Demonstrations of this nature have since been given from year to year, covering in turn different

districts. The usefulness of these demonstrations has been shown by the increasing number of farmers who have installed filters of their own.

Following the filtering demonstrations, the farmer was encouraged to bottle a small quantity of the cider as a trial. The successful results obtained from these trials proved to the farmer that it was a line worthy of development. As a good market was found for this class of cider, while the draught cider was becoming more difficult to dispose of, the quantity of bottled cider was gradually increased each year.

In order to develop this type of cider, a filter had to be installed. This meant an outlay of £30, being the cost of the smallest filter of the approved type, together with a pulp-washer. This expense was not a practical proposition until the farmer had established a considerable market for bottled cider. In some districts, however, the farmers overcame the difficulty by co-operatively purchasing a machine. In others, one farmer invested in a machine and filtered his neighbours' cider for a small charge. In this manner the scheme has developed and gradually, as the farmers increase their output of bottled cider, they are able to instal filters individually.

Although, as has been shown, the selection of varieties and the control of the fermentation were found to be the two most outstanding problems of the work, yet numerous other details regarding the farmers' methods of cider-making had to be improved in order to obtain good results.

Fruit Storage. Most farmers realised the necessity of storing the fruit in order to bring it to the ideal condition of ripeness before milling, but this was often done in a very careless manner. On the farm, storage under ideal conditions is not often possible, but the apples can be adequately stored out in the orchard on a floor of wooden planks, using hurdles to form bins. They are not liable to heat as long as the heaps are not more than 2 feet in depth.

Fruit Cleansing. Many farmers were under the impression that the cleanliness of the fruit was of no importance, because any dirt or soil with it would be discharged during the "working." Not alone from a hygienic point of view should the apples be clean: it was found that a better fermentation was obtained from clean fruit.

The washing of the fruit has been done occasionally on the farm when it was found to be very dirty and objectionable, but this was only done with a certain amount of difficulty by raking the apples through troughs of water. It was felt that washing was not necessary so long as the apples were stored under clean conditions.

Milling and Pressing. Very old types of mills were found to be still in use on the farms, the majority of which were either of the "tooth" or "scratcher" type, though the old circular stone mill was often found to be still employed.

Several farmers have recently invested in the modern "grater" mill and are finding that the higher yield of juice obtained from this soon pays for its cost.

The old farm presses were found to be very efficient in spite of their antiquity and, combined with a modern mill, give almost as high a yield of juice as the modern hydraulic press, although they are comparatively slow.

The building of the "cheese" with straw was still found to be the practice in some parts of Dorset and Monmouth. The use of horsehair press cloths was quite common, but these have recently been replaced to a large extent by coco-fibre or manilla which are lighter to handle and easier to keep clean.

The introduction of cotton cloths was not successful. Owing to the rather uneven pressure which cannot be avoided with the old farm screw-presses, they were quickly torn. For this same reason, the use of racks between the layers of pomace could not be introduced. They soon became broken.

Maceration of the pomace was found to be very rarely practised, except in the case of resoaking the pomace before pressing a second time.

The addition of varying quantities of water was a common practice with some farmers. It was suggested by them that the keeping quality of the juice was improved by the addition of water, but the writer's own experience has been that a watered "farm-house" cider is slightly more palatable than that without water only because the acetification is somewhat diluted by the addition of water.

The farmers were encouraged in any case to keep strictly to pure juice for bottling cider, for the sake of its good reputation.

Cask Treatment. The importance of the condition of the casks was treated very lightly by many farmers. It was disappointing to find a cider that would otherwise have been valuable spoiled by a cask taint.

The importance of a clean cask has constantly been emphasised, and the use of bisulphite of lime as an antiseptic has been recommended to keep casks sweet when empty; also the annual taking out of the heads and cleaning thoroughly has been advised.

Specific Gravity Records. The use of the hydrometer in farm cider-making was almost unheard of.

The advantage of the practice of recording the specific gravity of the juice at regular intervals during the fermentation, as a guide to its behaviour, has been instilled into the farmers.

Racking and Sulphuring. Racking and sulphuring were practised to some extent, but often only in a haphazard manner, which may or may not give good results. Sulphuring, by burning sulphur matches in the empty cask, was done more with the idea of keeping the cask sweet than as a means of controlling the fermentation of the juice.

Although filtering the juice has now been adopted for the control of the fermentation, yet racking and judicious sulphuring are still recommended in addition.

It has been found that racking and sulphuring as a rule checks even quickly fermenting juices to some degree, and this checking of the fermentation often results in a cleaner juice which eases the filtering operation.

Bottling. In the production of bottled cider, the farmer soon found that careful management was necessary in order to bring about just sufficient effervescence in the cider. Too much gas and too much deposit in the bottle often occurred; this was objectionable to the consumer and lowered the value of the cider.

Imperfect and mis-timed filtration were reasons for this occurrence in many cases and the system of double filtration was advised. The cider was filtered in the first place to arrest fermentation at the required specific gravity, and a second filtration prior to bottling, reduced the amount of after fermentation in the bottle considerably.

As the correct time to bottle varies with individual ciders, the Instructor has made it a practice to test samples from the farmers by incubation at Long Ashton, advising the makers on the correct time to bottle from the result of this test.

Acetification. Finally, some reference to the widespread prevalence of acetification in farm-made ciders must be made. While in occasional instances there is little room for criticism in this respect, much "farmhouse" cider shows the acetic character which has brought disrepute upon the class generally.

Two main reasons for the development of this taint have been observed during the course of the work:—(a) lack of care in the handling and storage of the fruit, resulting in the occurrence of acetification prior to milling and pressing, and (b) failure to exclude air from the liquor during the period when fermentation is subsiding, and afterwards during the storage period.

The simple precautions necessary to prevent acetification have been constantly stressed by the Instructor, and a marked improvement has been shown in the produce of the farmers who have availed themselves of his services.

CONCLUSIONS.

The work of the Instruction Scheme has led to the conclusion that, if the farmer is prepared to give the necessary attention to the production of cider, it can be turned into a profitable branch of farming. Several farmers who produce regularly a bottling cider have no difficulty in disposing of it at a price of 15/- to 20/- per dozen (champagne quarts), leaving a very considerable nett profit. Even with a lower price of 10/- to 12/- per dozen, bottled cider is much more profitable than the old fashioned "farmhouse" draught cider, which is often sold for 8d. or 10d. a gallon.

As far as the future of the cider industry on the farm is concerned, it is felt that more co-operation amongst the farmers is necessary.

In districts where a number of farmers are each producing comparatively small quantities of cider, the development of a local central factory would prove beneficial. The bulking of the smaller quantities of cider under such a scheme would result in a cider of a uniform character being produced in the district. It would also allow for the employment of more specialised labour and for the installation of more efficient and up-to-date machinery than would be economic for the individual small maker to invest in.

THE CLARIFICATION OF CIDER BY THE CENTRIFUGE METHOD—II.

BY O. GROVE.

Experiments on this subject were described in last year's report and a further series has been conducted during the 1930-31 season. These fall into two groups:—(1) fermentation control and (2) comparative trials of different types of centrifuges.

(1) *Fermentation Control.*

(a) During the beginning of December, 1930, the contents of 40 casks, containing each about 120 gallons of fermenting juice made from mixed apples, were passed through the Sharples centrifuge. The specific gravities of the different juices varied from 1.021 to 1.032 at the time of centrifuging. The casks were kept at ordinary temperature, the specific gravity of the juices being taken at intervals. At the end of March, 1931, about half of the casks showed a loss of 2 points in specific gravity: of the other half, 3 casks showed a drop of 4 points, the rest having lost 3 points.

(b) Similar casks containing juices fermented down to specific gravities varying from 1.012 to 1.016 and centrifuged at the same period showed drops of 1 or 2 points in specific gravity after 4 months at ordinary temperature.

In both sets of experiments, control casks of uncentrifuged juice fermented to dryness in 8—10 weeks.

It will be noted that the check to the fermentation in cask by the centrifuging of the fermenting juices was a very definite one, and it confirms the results obtained last year with centrifuged ciders kept in bottles.

All the juices used for the above experiments showed medium rates of fermentation.

(c) Experiments were also done with a juice having a very high rate of fermentation (Morgan Sweet). The juices were centrifuged at the following specific gravities: 1.012, 1.020, 1.027, 1.038 and 1.042. Some of the centrifuged juice was bottled and the remainder put in casks immediately after centrifuging.

With regard to the bottled samples, the specific gravities were after 4 months: 1.011, 1.016, 1.016, 1.021 and 1.030 respectively. With the exception of the two first lots, the fall in specific gravity was very large and several of the bottles burst after a time because of the excessive pressure developed. There were also heavy yeast deposits.

The cask samples, kept in casks of 15 gallons capacity, were all completely fermented after 4 months.

These results indicate that it is difficult to give a decisive check to the fermentation by centrifuging juices with very high rates of fermentation. Probably a second passage through the centrifuge after a suitable interval would have improved the results. This point is being tested during the 1931-32 season.

(2) *Comparative Trials of Different Types of Centrifuges.*

Some comparative tests were done with two centrifuges of different construction, viz., the Sharples centrifuge and an Alfa-Laval model. Details of these trials will be found in the table below. It appears from them that there was very little difference in the action of the two different types of centrifuges.

Another form of centrifuge is now under test. This is the continuous Alfa-Laval model, which is used in yeast factories for the separation of the yeast from the fermented wash. With a centrifuge of this construction it is possible to separate the fermenting juices in two lots; one part, about 10%, of a rather thick liquid containing the yeast and another part, about 90%, of cleared juice. The thick part can be left to settle for a few days and passed through the centrifuge again. The advantage of a centrifuge of this type is that it is continuous. About 200 gallons per hour can be treated with the size used for the present experiments.

The results in this case are not yet sufficiently advanced to report upon at the time of writing.

THE EFFECT OF STORAGE TEMPERATURE ON CIDER.—III.

BY O. GROVE.

In continuation of the series of experiments on this subject described in last year's report, four different ciders were bottled in the spring of 1931 and placed in cold storage (Temperature 1°C.) for varying periods. The object was to get further evidence as to the period of cold storage necessary to check excessive after-fermentation in the bottles, and also to find out at which time after bottling the period can best be introduced.

The ciders were selected blends of different degrees of sweetness. They were bottled on the 1st April, when they gave the following figures for specific gravity, acid and tannin :—

		Specific Gravity.	Acid % (as Malic).	Tannin %
Blend A	..	1.017	0.52	0.16
„ B	..	1.014	0.47	0.15
„ C	..	1.018	0.55	0.20
„ D	..	1.026	0.56	0.21

In each instance 20 sets of samples were used.

As indicated in the table which follows, the samples 7-12 were kept one month, and the samples 13-18 two months, at ordinary temperature before placing them in cold storage for different periods. The samples 1-6 were put in cold store immediately after bottling and removed to ordinary temperature after different periods of cold storage.

Only the specific gravities and the degree of effervescence are given in the table as being sufficient evidence of the fermentations, which had taken place in the bottles. The state of effervescence is indicated thus :—0 = none, 1 = slight, 2 = good, 3 = strong, 4 = vigorous effervescence. The two last figures, 4 especially, indicate too much effervescence for commercial purposes.

With regard to Cider A, the control sample (20), kept at ordinary temperature, had developed too much fermentation during the six months over which the experiments extended. A sufficient check was obtained with one or, better, one and a half months' cold storage, and it did not make any discernible difference whether the period was applied after one or two months at ordinary temperature or immediately after bottling.

TABLE I.

No. of Sample.	Date of placing in Cold Store.	Date of removal from Cold Store.	Period of Cold Storage.	Cider A.		Cider B.		Cider C.		Cider D.		Cider D. Acid Percentage (as malic). Dec. 1931.
				Specific Gravity.	Effervescence.	Specific Gravity.	Effervescence.	Specific Gravity.	Effervescence.	Specific Gravity.	Effervescence.	
1	1 April	1 May	1 month	1.016	2	1.012	2	1.015	3	1.023	4	0.31
2	"	15 "	1½ "	1.016	2	1.012	2	1.015	3	1.023	4	0.31
3	"	1 June	2 months	1.016	2	1.012	2	1.016	2	1.024	3	0.30
4	"	15 "	2½ "	1.016	2	1.012	2	1.016	2	1.023	4	0.29
5	"	1 July	3 "	1.016	2	1.013	2	1.016	2	1.024	3	0.30
6	"	1 Aug.	4 "	1.017	1	1.014	1	1.017	2	1.024	3	0.30
7	1 May	1 June	1 month	1.016	2	1.012	2	1.016	2	1.023	4	0.32
8	"	15 "	1½ months	1.016	2	1.012	2	1.016	2	1.023	4	0.31
9	"	1 July	2 "	1.016	2	1.013	2	1.016	2	1.023	4	0.32
10	"	15 "	2½ "	1.016	2	1.013	2	1.016	2	1.023	4	0.38
11	"	1 Aug.	3 "	1.016	2	1.013	2	1.017	1	1.024	3	0.33
12	"	1 Sept.	4 "	1.016	1	1.014	1	1.018	0	1.025	2	0.41
13	1 June	1 July	1 month	1.016	2	1.013	2	1.015	3	1.023	4	0.30
14	"	15 "	1½ months	1.016	2	1.012	2	1.017	2	1.024	3	0.30
15	"	1 Aug.	2 "	1.016	2	1.012	2	1.017	2	1.023	3	0.28
16	"	15 "	2½ "	1.016	2	1.013	2	1.016	2	1.023	3	0.29
17	"	1 Sept.	3 "	1.017	1	1.013	2	1.017	1	1.025	2	0.36
18	"	1 Oct.	4 "	1.017	1	1.014	1	1.016	2	1.024	3	0.35
19	1 April	1 "	6 "	1.017	0	1.014	0	1.018	1	1.026	0	0.42
20	At Ordinary Temp.	At Ordinary Temp.	—	1.015	3	1.012	2	1.015	3	1.020	4	0.32

Similar results were obtained with Cider C, although in this case a period of about two months' cold storage was necessary to keep the fermentation in bottle within bounds.

In the case of Cider B, which started at the specific gravity of 1.014, cold storage was of no advantage, as the control sample (20) kept at ordinary temperature did not show too much fermentation in the bottles.

Cider D, which was bottled at a comparatively high specific gravity (1.026), showed a vigorous fermentation in the control bottles (20), and although a shorter period of cold storage had some effect on the rate of fermentation, at least three months were necessary to check the fermentation sufficiently.

The last column in the table indicates the acid percentage (as malic acid) in Cider D. The acid determinations were made in December 1931. It will be seen that a cold storage period of three to four months checked to some extent the drop in acidity, although this was not the case with the samples 5 and 6, which, at the time of the acid determination, had been out of cold store six and five months respectively.

CONCLUSIONS.

It is evident from these results that the response of different ciders to cold storage treatment is not entirely uniform, the behaviour being closely related to the capacity for residual fermentation inherent in the individual cider concerned. This, as research in other directions has shown, is associated with the amount of nitrogenous material remaining in the cider at the time of bottling.

From this it may be concluded that, for ciders of the sweet or medium sweet types, a period of from one to two months' cold storage is effective in maintaining in good condition the naturally conditioned bottled article for a considerably longer period than is possible by storage at ordinary cellar temperature, provided that the cider in question is in suitable condition for bottling in respect of capacity for residual fermentation. In such cases, the actual time during the summer months at which the cold storage is applied appears to be immaterial.

For low gravity ciders in which there remains little or no capacity for residual fermentation, cold storage offers little, if any advantages.

For ciders bottled prematurely and subject to excessive after-fermentation in bottle, a limited period of cold storage treatment does not suffice to keep this fermentation in adequate check for any useful period of time after removal from the store.

CIDER MAKING TRIALS WITH APPLES FROM BRITISH COLUMBIA.

BY O. GROVE.

At the instance of the Department of Agriculture of the Dominion of Canada a number of different varieties were tried for cider-making with the utilisation of low grade fruit for this purpose in view.

The apples were received during the end of November 1930 and were milled and pressed on the 15th December. They were all Grade 3 and in good condition. About half a ton of apples of each variety was used.

Some of the sorts, namely Mackintosh, Grimes Golden and Winter Banana were rather difficult to press, the flesh being very soft and passing through the press-cloths. These three varieties seemed a little over-ripe and would have given better results if it had been possible to press them earlier; a better yield of juice would also have been obtained in this case. Staymen, Newtown and Winesap were in excellent condition from the cider-making point of view.

The juices were left to ferment until the specific gravities had fallen to the points indicated in the table below, when they were filtered through a pulp filter. They all filtered well. Some of the low acid varieties such as Mackintosh and Delicious would probably have made better ciders if they had been filtered a little later, *e.g.* at a specific gravity of 1.018—1.020. As treated, they proved rather too sweet.

The ciders were all bottled directly from the filter.

The samples were examined on the 10th of March, 1931, when the following points were noted:—

Mackintosh. Cider sparkling with very small deposit. Flavour sweet and fruity, quite pleasant. Rather too sweet.

Rome Beauty. Cider lightly sparkling; no deposit. Flavour quite fair. Has more character than the preceding.

Grimes Golden. Cider lightly sparkling ; no deposit. Very fair cider, similar to Rome Beauty, but better in flavour.

Winter Banana. Cider sparkling with very small deposit. Not very good, flavour rather inferior.

Jonathan. Cider lightly sparkling ; no deposit. Very fair cider with pleasant brisk flavour.

Delicious. Cider lightly sparkling ; no deposit. Rather too sweet, otherwise flavour quite fair.

Staymen. Cider lightly sparkling ; no deposit. A good cider with pleasant flavour and more "body" than the rest.

Newtown. Cider sparkling with small deposit. Quite fair cider with a brisk flavour.

Winesap. Cider lightly sparkling ; no deposit. Not very good.

All the ciders kept well during the summer.

Upon the whole the ciders may be considered to have been a very fair lot. They all lacked "body" in comparison with ciders made from English cider apples and, as usual, this feature was found in association with very low tannin percentages.

The following table gives further details :—

Variety.	Date of Pressing.	Yield of Juice in gallons per ton.	Specific Gravity of Fresh Juice.	Malic Acid per cent.	Tannin per cent.	Rate of Fermentation.	Date of Filtering.	Specific Gravity at time of Filtering.	Specific Gravity 10/3/31.	Alcohol per cent. by Weight.
Mackintosh	15/12/30	153	1.041	0.32	0.06	4.6	7/1/31	1.025	1.024	2.08
Rome Beauty	"	159	1.048	0.37	0.06	5.1	27/1/31	1.020	1.019	3.36
Grimes Golden	"	156	1.052	0.40	0.06	6.5	12/1/31	1.024	1.022	3.52
Winter Banana	"	162	1.052	0.38	0.08	6.0	24/1/31	1.020	1.019	3.94
Jonathan	"	177	1.047	0.46	0.06	5.6	20/1/31	1.021	1.019	3.17
Delicious	"	163	1.048	0.26	0.06	7.3	7/1/31	1.025	1.024	2.82
Staymen	"	170	1.058	0.49	0.08	7.0	27/1/31	1.024	1.022	4.13
Newtown	"	175	1.050	0.53	0.07	3.7	10/2/31	1.027	1.026	2.92
Winesap	"	178	1.055	0.51	0.08	4.1	6/2/31	1.026	1.025	3.50

THE DOMESTIC PRESERVATION OF FRUIT AND VEGETABLES.

PROGRESS REPORT 1926—1931.

BY MARGARET L. ADAMS.

The main subject of this report is the general progress of the department dealing with the domestic preservation of fruit and vegetables between the years 1926 to 1931. In introduction, a brief account of the origin of the department may be of interest.

That such work ever came into being was an indirect result of the Great War. During the war period there was an urgent need for the increased production of raw food materials and for the preservation of certain kinds of such materials. The Food Production Department was established and part of its work was to encourage everyone to grow more produce and to preserve surplus supplies for use during the winter months. Large quantities of fruit were preserved at that time, but the methods and results were not always very satisfactory, partly on account of incomplete knowledge and partly because of the very restricted use of sugar. As the result of the experience gained during those years, a feeling existed at the end of the war that there was great scope for investigation in the subject of fruit and vegetable preservation. The years immediately following the war showed that a very large quantity of fruit was wasted annually in cottage and larger gardens. The waste, to some extent, was due to the fact that the owners of gardens had been encouraged to increase the production of fruit, but many of them possessed little knowledge as to the most satisfactory methods of preserving their surplus supplies. This situation, combined with a need for information on a commercial scale, resulted in the gradual development of the Fruit and Vegetable Preservation Research Station at Campden, in Gloucestershire. Until 1931, the department dealing with the domestic preservation of fruit and vegetables was located at Campden: in the year named, it was transferred to the Long Ashton Research Station.

The primary aim of the department has been to give owners of fruit gardens reliable and practical information as to the best methods of preserving surplus supplies, and to encourage the

preservation of home produce as widely as possible, not solely from the standpoint of preventing waste of fruit and vegetables but also from a dietetic one.

Before the department could proceed with its instructional and advisory service, experimental work over a wide field had to be carried out. The initial investigations dealt with the preservation of all kinds and varieties of English fruits and vegetables by bottling, canning, jam-making, pickling, etc., and when methods of practical utility had been evolved, they had to pass a test as to their suitability for rural homes, where in many cases expense and difficulties of equipment in regard to water supply and heating apparatus are very important matters. Following on the experimental work, a series of leaflets was published dealing with the preservation of different fruits. As these were written in simple language and gave clear directions as to methods, they became popular and were an important factor in the development of extensive educational activities.

There have always been two distinct sides in this work—the experimental and the educational. Till 1926, the experimental side was the more important; from 1926, the educational activities have predominated. The educational side could be developed only on and after the very sure foundation which was supplied by the accurate experimental work carried out by the first Instructress who was the predecessor of the writer of this report.

The development of the department since 1926 onwards may be considered very briefly under the following heads:—

1. Educational and Advisory.

- (a) Summer Courses.

- (b) Courses and lectures to Board of Education students.

- (c) Activities in connection with the Women's Institute movement.

- (d) Produce Exhibitions.

- (e) Advisory.

2. Experimental.

1. EDUCATIONAL AND ADVISORY.

- (a) *Summer Courses.*

Although ten-day practical courses in the preservation of fruit and vegetables have been given during the summer months at Campden since 1920, it is only within the last few years that they have become well known and that the number of applications has exceeded the vacancies. The great increase of interest has been due partly to a deliberate expansion of the extra-mural work of

the department and partly to the very definite tendency there has been during the last few years to recognise the importance of practical education for rural women and girls. The most interesting Denman Report on "The Practical Education of Women for Rural Life" was published by the Ministry of Agriculture in 1928. One of the results of this Report was that all Agricultural Education Committees of the County Councils were circularised by the Ministry requesting them to make definite provision for the practical education of women. This action has had a direct effect on the work of the department, since fruit preservation enters into all schemes dealing with this subject, and in order to be in a position to provide instruction, several County Councils who were able to accede to the Ministry's request have sent students to attend one or other of the Summer Courses. The Women's Institutes were particularly interested in the Denman Report, and in some counties where the County Council could not supply instruction in fruit preservation, the Women's Institute County Federations selected candidates for instruction. This action led to a difficult situation which is discussed later when considering Women's Institute activities. The County Council Education Committees, as distinct from the Agricultural Education Committees, have also shown an increasing interest in the Courses and have assisted many teachers of Domestic Science in rural districts to attend one of them by paying all or a portion of the fee.

Different types of students have attended the Courses, but most of them do so because they have to teach the subject of fruit preservation when they return to their respective districts. This, in conjunction with the fact that this department is the only specialised training centre for the subject in this country, makes it very necessary for the information given to be not only reliable and up-to-date, but also for the methods used to be essentially practical.

Previous to 1931 the Courses were held at Campden, but with the transfer of the department to Long Ashton it was found desirable to alter the original arrangements. Accommodation for the Courses was offered at the Royal Agricultural College, Cirencester, by the College Authorities, and as a result of this arrangements were made to hold the Courses at the College, commencing from the summer of 1931. The accommodation provided for the students at the new centre is excellent, and the facilities now available should ensure the smooth running and success of the Courses in the future. The practice kitchen in which all students receive instruction is well equipped, but students are encouraged to use alternative methods and are not allowed to forget the diffi-

culties which are always attached to the teaching of any practical subject in a rural area.

Every Course covers a ten-day period and usually 4—5 Courses are given in one season. The average number of students who have received instruction each summer is 60.

(b) Courses and Lectures to Board of Education Students.

At various times the Board of Education has reserved all the vacancies in one of the Summer Courses and has sent to it selected teachers of Domestic Science from all over England. For reasons of economy, this particular type of Course has not been held during the last three seasons, but instead the Instructress has been asked to lecture at week-end Refresher Courses organised by the Board of Education for teachers of Domestic Science in rural districts. That the subject of fruit and vegetable preservation is being more and more recognised by the Board as an essential part of the practical education for rural women is evidenced by the fact that out of a 3-day Course one whole session of 3 hours has been devoted to the subject on more than one occasion. Such lectures have been given during the winter and their success has led to the formation of a special scheme of winter work among Women's Institutes.

(c) Activities in connection with the Women's Institute Movement.

Any department of education which has for its main purpose the distribution of knowledge among women in rural areas has to-day an organisation in the Women's Institute Movement whose machinery is excellent for the achievement of that purpose. This fact has been recognised by the Ministry of Agriculture, the Board of Education and by County Councils. The Women's Institute Movement has been used extensively by this department as the principal channel through which to supply women in country districts with information, and the organisation has formed a basis for the very considerable expansion of all branches of educational work dealing with the preservation of fruit which has taken place during the last five years.

Since 1926, the policy of the department has been to bring its work to the notice of the County and National Federations of Women's Institutes rather than to the individual Institutes. The County Federation links up all the Institutes in a county and the National Federation is the central body co-ordinating the whole movement in England. The reason for dealing with the Federations is that the work of the department is designed to cover the whole country, and any attempt to cope with the needs of individual

Institutes as such would be impossible since there are 5,000 of them in England. It is recognised as important that the work of the department should have a definite place in any national scheme for the development of women's education for rural life, and one of the best ways of achieving this objective is to co-operate to the fullest extent with the County and National Federations.

Although no lectures or demonstrations are given from the department to individual Institutes, their needs are provided for because, as has been mentioned before, the County Councils and other bodies interested in rural education are sending an increasing number of students to the Summer Courses. Such students eventually spend a considerable portion of their time demonstrating at Institutes. It may be said that the bulk of the information which has provided the basis for the teaching of this subject all over England has been supplied by the department.

It has been mentioned earlier that Women's Institute County Federations have at different times sent selected candidates to attend one of the Summer Courses. This has been done usually in counties where the County Council could not supply instruction, and the students sent have been expected, as a result of attending a Course, to be in a position to give instruction in fruit preservation in their respective districts. Such students, in the majority of cases, had little previous knowledge of demonstrating or lecturing, with the result that their efforts in this direction sometimes failed to advance the object in view. To encourage such students risked a serious lowering in the standard of teaching, but it was quite obvious that the number of trained teachers with the required information fell very far short of the demand. In an effort to provide demonstrators and at the same time keep up the standard of teaching, a short course in methods of teaching fruit preservation at Women's Institutes was organised by the department in 1929 for Women's Institute members who had previously attended one of the 10-day Courses. The Course was successful as far as it went, and it certainly gave the students some idea of the methods to be adopted in presenting their subject to a rural audience. On the representation of the department to the National Federation of Women's Institutes, the whole subject is being considered very carefully by that body.

In the past, it was assumed that the teaching of fruit preservation could be carried out satisfactorily only during the summer months. This meant that the Instructress was available for extra-mural work for two months only, usually June and September, as the months of July and August were devoted to the Summer Courses. During the last few years, the calls upon the time of the Instructress

during the above months were so numerous that there was no possibility of her being able to cope with more than a small percentage of them. This demand may seem strange in view of the previous statement that an increasing number of teachers have been attending the Summer Courses, but it is explained by the fact that such teachers can devote only a minimum of their time to the teaching of fruit preservation, as most of it is employed by County Councils in other directions. This situation, coupled with the constant growth of the Women's Institute Movement and its interest in the subject of fruit preservation, has led to increasing demands on the department. In an endeavour to meet this demand, and so make the department of more value to rural women, a scheme was evolved which was the result of co-operation on the part of the Ministry of Agriculture, of the National Federation of Women's Institutes and of the department. The scheme provided for the giving of two and three-day Courses in fruit preservation during the winter months—October till April. The Courses were offered to the County Federations, who undertook to send suitable candidates to the most convenient centres in the respective counties. Full advantage has been taken of this offer, and classes have been organised all over England. Although very little fruit was available, there was always sufficient of one kind or another to illustrate quite clearly the various principles underlying fruit and vegetable preservation. The scheme has justified its trial, and it is hoped that it will be continued, as it relieves a very heavy summer season and is serving a definitely useful purpose.

The useful co-operation between the department and the Women's Institute Movement has been helped greatly by the representation of the department on County and National Federation Committees.

(d) Judging at Produce Exhibitions.

A few years ago, the various Exhibitions organised by Committees representing County Federations of Women's Institutes, Root, Fruit and Grain Societies, Flower Shows, etc., had perhaps one class for preserved produce; if there were any entries, they were placed in the darkest corner of the Exhibition and, though a few were excellent, the majority were of poor quality. This state of affairs was due partly to a general lack of interest in the subject and partly to a lack of reliable instruction. To-day the position is very different and the task of judging preserved produce is a very arduous one. The department supplies a judge for all the principal Produce Exhibitions, and a definite policy of trying to make the judging of educational value to the exhibitor has been followed on all possible occasions. To carry out this policy, the judge always endeavours to give the exhibitor some constructive

criticism, and a full report on the judging is sent to the Committee concerned. Such reports have been appreciated and suggested improvements regarding the schedule and conditions of exhibiting have often been acted upon.

Owing to the great increase in the number of Produce Exhibitions and in the number of classes for preserved produce, there has been a very great dearth of reliable judges. In order to increase the supply of judges, an experimental scheme, initiated by a member of a County Council Staff and carried out by the combined efforts of the particular County Council, the County Federation of Women's Institutes and the department, has proved most successful. The scheme provided for practical instruction in the judging of produce, and only selected candidates were allowed to attend. It is hoped that similar schemes will be developed in other counties in the near future. The lack of judges has been a serious difficulty, but an even more serious one has been the lack of uniformity in standards among the available judges. In an effort to improve this situation, the department has produced a scale of awards for the judging of preserved produce, which has been incorporated in a pamphlet on produce exhibitions issued by the National Federation of Women's Institutes.

(e) Advisory Work.

The guiding principle in the advisory work, as in all other activities of the department, has been simplicity. Much advisory work has been accomplished by the publication of leaflets, which are designed by simplicity of language and methods to serve in particular those whose equipment and means are limited.

Wireless talks during the summer months have increased considerably the volume of advisory work.

One important aspect of the advisory work has been the keeping in close touch with all students who have attended Courses and who are now teaching the subject of fruit preservation. By this means, the knowledge of old student teachers is kept up-to-date and the information given to the public is fairly uniform over a very wide field.

2. EXPERIMENTAL.

Although the experimental work has been diminished during the last few years while attention has been concentrated chiefly on the training of teachers, it has been progressing steadily. The following subjects have received special attention :—

The making of pickles and chutneys.

The crystallising of fruit.

The preservation of marrows.

The use of commercial pectins with special reference to their use in strawberry and raspberry jams.

The making of jams and marmalades in domestic Pressure Cookers.

During the summer of 1931 series of variety trials were carried out in connection with the canning and bottling of raspberries, cultivated blackberries and gooseberries.

During the period under review general progress has been made along the lines indicated, and in some measure the ultimate aim of the department, that of giving the public reliable information on the preservation of fruit and vegetables, has been steadily advanced. Much of the future work will be developed along similar lines as hitherto, but more prominence will again be given to the experimental side. The further development of the experimental work is becoming necessary, and in the future more time should be available to undertake it as the supply of competent teachers increases.

THE VALUE OF YOUNG BAT WILLOW TREES.

BY H. P. HUTCHINSON.

Bat willows have a market value only at the time of their maturity which may be from 12 to 25 years from the time of planting. As young immature growing trees and according to age, they possess potential value which it is frequently necessary to ascertain in cases where changes of ownership occur or where claims are made by the owner for damage sustained from stock, fire or other causes. Hitherto, valuations appear to have been made from eye judgment, values being arrived at from the general appearance of the trees, a knowledge of their ages and by comparison made with other bat willow trees in the immediate neighbourhood.

The principal factor in the determination of the value of young willow trees being rate of growth, monthly records of growth were commenced on six cricket bat trees, growing on the Willow Trial Beds of the Research Station, Long Ashton, in 1928. The growth figures so obtained, together with the current price of cricket bat timber, enable their values to be calculated at any time during this period.

The trees were planted as long unrooted sets of 4 years growth on April 3rd, 1928. Girth measurements were taken immediately after planting and afterwards at monthly intervals during the growing periods of the year at distances of about 5 feet from ground level. The places of measurement were permanently marked with India ink as bands girdling the stems. The following figures have been extracted from these records.

TABLE I.
Girth Measurements in Centimetres.

Tree.	April 1928.	Nov. 1928.	Nov. 1929.	Nov. 1930.	Nov. 1931.
No. 1	13.3	15.6	19.4	24.5	34.4
" 2	13.5	15.5	19.6	24.1	31.9
" 3	14.1	15.8	21.3	26.7	35.2
" 4	14.1	15.4	20.5	25.8	34.4
" 5	12.4	15.2	23.2	33.5	46.0
" 6	14.9	16.7	24.5	35.5	48.3

The increases in growth are satisfactory since, if maintained at these rates, the time required for the trees to attain a girth of 48 inches would be as follows :—

Tree No. 1	..	..	22 years.
.. " 2	..	..	27 "
.. " 3	..	..	22 "
.. " 4	..	..	23 "
.. " 5	..	..	14 "
.. " 6	..	..	14 "

By approximate calculations made on these figures and a length of bole of 10 feet the annual volumes are as follows :—

TABLE II.
Volumes in Cubic Inches.

Tree.	April 1928.	Nov. 1928.	Nov. 1929.	Nov. 1930.	Nov. 1931.
No. 1	252	344	544	861	1693
.. 2	261	340	550	818	1454
.. 3	283	355	651	1022	1775
.. 4	283	340	600	951	1710
.. 5	219	331	770	1585	3017
.. 6	317	397	861	1800	3357

The values given in the following table are calculated from the volumes given in Table II, and the price of good quality cricket bat timber (21/- per cubic foot).

TABLE III.
Values of the Trees.

Tree.	April 1928.	Nov. 1928.	Nov. 1929.	Nov. 1930.	Nov. 1931.
No. 1		4/3	6/8	10/6	20/7
.. 2	} 3/- per Set.	4/2	6/8	10/-	17/8
.. 3		4/4	7/10	12/6	21/7
.. 4		4/2	7/3	11/7	20/9
.. 5		4/-	9/4	19/3	36/8
.. 6		4/9	10/5	21/10	40/9

These values apply to young trees which are making satisfactory growth and are free from major faults. In cases where defects are present such as crookedness of butts, wounds and diseased patches, deductions in value from the above figures should be made. Similarly deductions should be made where soil and other conditions are adverse to satisfactory growth, even to the limit of assigning no value to trees whose growth records show that they would never make suitable bat timber.

REPORT ON ADVISORY WORK, 1930-31.

Although the number of enquiries received during the year ending September, 1930, showed a very large increase over the numbers submitted in any previous year, the figures for 1931 show a further increase over the 1930 record, thus demonstrating the continuous steady expansion of the advisory activities of the Department.

Of the ten subjects which contribute to the advisory statistics, increases were recorded in eight, viz.: Agricultural Chemistry, Dairy Bacteriology, Cider and Fruit Products, Cider Instruction, Pomology, Horticultural Chemistry, Economic Entomology and Disease Control Materials and Methods.

The increases in the cases of Cider Instruction, Pomology, Economic Mycology and Willow Growing were very substantial and may be accounted for by special activities of the members of staff concerned with these subjects. Thus under the Cider Instruction Scheme, the production of good quality bottled cider on the farm has aroused great interest among farmer cider makers in certain areas; in Pomology, the rapid increase reflects the great interest which growers take in the Pomological investigations in progress at Long Ashton; the Mycological increases are largely the result of fruitful investigations relating to vegetable diseases, whilst a considerable proportion is also due to enquiries relating to hop diseases; in Willow Growing, the increase is especially large due to interest recently aroused by the Willow Officer in the subjects of pest control and the cultivation of the cricket bat willow.

The decreases shown in both Economic Entomology and Disease Control Materials and Methods are almost entirely due to the fact that in the previous year the numbers were abnormally high as a result of enquiries by manufacturers of winter washes and growers, relating to the making and utilising of the recently devised Long Ashton Winter Wash, and other related spray fluids.

The following table summarises the numbers of enquiries submitted during the last six years.

				Year ending September 30th.				
			1926	1927	1928	1929	1930	1931
Gloucester	..	..	277	268	229	230	365	414
Hereford	..	..	92	115	100	118	137	159
Somerset	..	..	336	307	336	325	482	553
Wiltshire	..	..	225	143	206	235	219	265
Worcester	..	..	104	168	162	148	256	323
Other Areas	..	..	309	478	495	721	1025	919
				1343	1419	1528	1777	2484
							2484	2633

Included in the figures under "other areas" are enquiries received from Devon and Monmouth, both of which contribute annual grants to the Long Ashton Institute, and from Dorset, which participates in the Scheme for Local Instruction in Cider-making. None of these counties ranks officially as part of the Bristol Province for general advisory purposes, though an arrangement has been made during the year, with the concurrence of the Ministry of Agriculture and Fisheries and the Commissioner for Agriculture for Wales, whereby Monmouth is recognised as part of the Bristol Province for Advisory purposes relating to Horticulture.

The list does not indicate the very numerous enquiries dealt with in personal interviews during survey work, local investigational work, shows, etc. Enquiries relating to the subjects of Agriculture, Economics, Veterinary Science and Fruit and Vegetable Preservation are not included, since figures are not available for these subjects over the six year period.

The following features referred to in the sectional reports which follow call for special mention :—

Agriculture and Agricultural Chemistry.

The number of requests for advice and the number of visits to farms, dairies, mills, etc., have again increased considerably. The Agricultural Officer is working in close co-operation with many of the feeding stuff manufacturers in Bristol and district, and his advice has been sought freely on the question of the composition of rations for cattle, sheep, pigs and poultry.

During the year the following investigations, which have been outlined in previous reports, have been concluded :—(a) Bracken Eradication ; (b) Suitable varieties of Sugar Beet ; (c) Mixed Corn Crops for home consumption ; (d) the value of Arctic White Sweet Clover. Reports have been issued on each investigation.

The work of the Department in connection with grassland problems has increased very rapidly, and it is desired to extend this activity still more in the future. The feeding value of grass throughout the whole year is being examined, and a collection of over 1,000 grass and hay samples from many areas in the Province and elsewhere has been made. These samples, which represent all types and conditions of grassland, have been dried, pulverised and bottled. Many of them have already been analysed, and some valuable data obtained. A section of this work is being conducted jointly with the Royal Agricultural College, Cirencester, which in addition, co-operates with the Department in many of the Provincial Trials. The financial assistance of the Bath and West and

Southern Counties Agricultural Society towards this grassland work has made it possible to widen the scope of the enquiry very considerably.

The field work in connection with the Longleat grazing trials is to conclude at the end of the present grazing season, after a continuous run of five years. Whilst an extension of this side of the investigation would have been very desirable, it is hoped that the field data already collected, together with chemical data from the analysis of the herbage and soil samples, will provide useful and practical information to grassland farmers in the Province.

Certain aspects of the Sugar Beet problem are still receiving attention for, although the manurial and cultivation trials conducted during the past four years have provided sufficient information for general advisory purposes, there are still a number of special problems, such as the question of the most suitable forms of phosphatic manure to use with the crop when grown on acid land, which require further detailed investigation.

Agricultural Economics.

The investigational work that has been carried out by the Advisory Economist during the past six years has now reached the stage when it can be used as a safe basis for advisory work. This is the outcome of a consistent policy of collecting as many financial records as resources of staff and finance have permitted.

The Adviser was asked by the Ministry to prepare a national scheme for ascertaining the cost of production of strawberries. This scheme has now been adopted by four centres, in addition to Bristol, and the collection of the necessarily large amount of data has been begun in Herefordshire and Worcestershire. It is hoped to extend the enquiry into the Cheddar Valley district.

The enquiry into the cost of production of sugar beet during the past four years has been concluded, and the results and conclusions embodied in a University Bulletin.

A new series of periodical publications is being made, dealing with the application of statistical methods to farm accounting data. Under this new development, three reports have already been published and others are in the course of preparation.

Dairy Bacteriology.

Since this section has been in existence for over six years, it is possible for the first time to include in the Departmental summary comparative figures for the annual number of enquiries received over the six year period. It will be noted from the following

table that during the six year period the annual number has been almost doubled, although it has not been possible to increase the Staff for dealing with the large amount of routine work, which has always been an essential part of the function of the Dairy Bacteriologist.

ENQUIRIES IN DAIRY BACTERIOLOGY.
January 1924 to September 30th, 1931.

Years ending September 30th.						
Jan. 1924 to Sept. 1925.	1926.	1927.	1928.	1929.	1930.	1931.
33	127	117	161	173	202	232

The Dairy Bacteriologist is examining the possibility of using simpler methods of testing milk samples received in connection with the Register of Accredited Milk Producers and an experimental scheme is to be started in Wiltshire at the beginning of 1932.

The Advisers in Dairy Bacteriology and Veterinary Science are co-operating with the Wiltshire County Council and the National Institute for Research in Dairying in a farm demonstration of the value of autogenous vaccines against mastitis, which disease involves many farmers in considerable financial loss annually.

Veterinary Science.

The Adviser in Veterinary Science commenced his duties at Berkeley Square in the middle of May, 1931, so that his activities outlined in the report cover only a period of four months so far as the Bristol Province is concerned. Even in this short time, there has been ample evidence of the necessity for this Officer in the Province, particularly in connection with the diseases of sheep and poultry. The Adviser is at present engaged on a survey of the most important diseases of farm stock in the Province, and from the preliminary information already obtained, it is certain that he will have many important problems to investigate.

Economic Entomology.

The Adviser in this subject has continued to pay special attention to field problems relating to the use of winter washes as means of controlling such pests as Capsid Bugs, Winter Moths, etc. A comprehensive series of field experiments was carried out with washes of this type on apples and black currants, a new feature being the testing of heavy mineral oils on a large scale under varied conditions. Washes containing mineral oils have given excellent

control of capsids on black currants, but with apples there were some cases where satisfactory commercial controls were not effected, the results being somewhat variable.

Economic Mycology.

The year under review has seen considerable advances in knowledge of vegetable diseases occurring in the Province. Several hitherto obscure diseases of asparagus, dwarf beans, peas, leeks, onions and marrows have been fairly well elucidated. Particular emphasis has been laid on the field aspects of these and other vegetable diseases and methods of complete or partial control have been evolved in several instances.

Certain diseases of hops assumed serious proportions during the year in the intensive hop growing areas of Worcestershire and Herefordshire, and these have called for special attention. Special measures have been taken, in conjunction with the Ministry's Inspector for the areas and the Officers of the County Agricultural Authorities concerned, to deal with the situation in 1932.

Willow Growing.

Advisory work relating to willow culture continues to expand as the results of investigations at Long Ashton become more widely known among growers. In particular, enquiries relating to the control of pests and diseases, a subject much neglected hitherto, and to the cultivation of the cricket bat willow have been numerous.

The subjects covered by the advisory work of the Department are Agriculture, Agricultural Chemistry, Agricultural Economics, Dairy Bacteriology, Veterinary Science, Cider and other Fruit Products, Fruit and Vegetable Preservation, Pomology, Horticultural Chemistry, Economic Entomology, Economic Mycology, Disease Control Materials and Methods, and Willow Growing.

The salient features of the work under each of these during the year are summarised below.

AGRICULTURE.

Since the appointment of the Agricultural Officer in 1931, the advisory work of the University in connection with general Agriculture has increased very considerably, more particularly with reference to grassland, farm stock and rationing. Most of the stock food manufacturers and "compounders" in Bristol have sought advice concerning the composition of balanced rations for cattle, sheep, pigs and poultry. A number of lectures on the feeding of live stock and animal nutrition has been given. Many herbage plants and weeds have been received for the purpose of identification

and report as to commercial value, poisonous properties, etc., and the co-operation of the Department of Botany of the University in this work is readily acknowledged.

The various activities within the Bristol Province relating to grassland, initiated by Professor Hanley, have been continued. In addition, co-operative work with the Royal Agricultural College, Cirencester, on the subject of the manuring of grassland for pasture and hay was commenced in the spring. Soil and herbage data are being collected from the plots situated at the College.

AGRICULTURAL CHEMISTRY.

319 requests for advice were received and 792 samples were analysed in connection with these enquiries.

The main investigations in progress or completed during the year were as follows :—

(1) *Grass Land.*

(a) *Longleat Grazing and Manuring Experiments.*—The sampling of the herbage and soil from 16 plots at this centre has been continued. Complete stocking and botanical records have been kept by the resident recorder. The experiment was planned to continue for a period of 5 years in the first instance, but it was hoped that an extension would be granted by the owner of the estate. Unfortunately this has not been obtained, so that the field work terminated with the close of the present grazing season.

The laboratory work in connection with the large number of grass and soil samples that have been collected during the past five years from the plots remains to be done, and it is hoped that the necessary financial arrangements will be made to complete this branch of the investigation.

(b) *Development Commission Pasture Experiments.*—The trial plot situated on the Marlborough Downs has been continued during the present season and although there appears to be a possibility that the scheme as a national one will be discontinued, arrangements have been made to continue, so far as the Bristol centre is concerned, for a further period. The chemical analyses of the herbage, which were formerly carried out elsewhere, will be conducted at Bristol.

(c) *Nutritive Value of Pasture Grass.*—The examination of the large number of samples (approximately 1,000) which have been collected from grassland trial centres in the Province and elsewhere, has been continued during the year. Attention is also being paid to the feeding value of winter grass.

(2) *Arable Land.*

(a) *Sugar Beet.*—Two trial centres have been established in the Province, both on comparatively light soils, where crop failures due to acidity have been reported for a number of years, with the view to studying the value of basic slag alone, against dressings of other phosphatic fertilisers and lime on the sugar beet crop. A full report on these experiments appeared in the Journal of the Bath and West Society for 1931.

The variety trials referred to in the previous report were concluded during the year. Marsters Hilleshog and Kleinwanzleben E. produced the highest average yield of sugar per acre throughout the Province, and Zapotil I the lowest. The highest yield of tops was obtained from Zapotil I, whilst the lowest was produced by Marsters.

(b) *Flax.*—The flax manurial trials conducted in Somerset, Wiltshire and Dorset (in collaboration with the Reading Province), have been continued during the present season on a modified scheme in view of the information obtained from the trials carried out in the previous year, which indicated that the quantities of phosphatic and potassic fertilisers usually employed could be decreased, or conversely the amount of nitrogen increased.

(c) *Mixed Corn Crop Trials.*—The following conclusions have been made on the results of the Winter and Spring Sown Mixed Corn Crop Trials conducted last year: (a) the success of mixed corn crops harvested for grain is dependent upon suitable weather conditions, and suitable varieties of legumes and cereals; (b) during the season 1929 there was a reduced yield in the case of the winter sown crops as compared with single crop controls; (c) the depredations of birds, etc., seriously affected the yields from the spring sown crops, the leguminous seeds suffering most from such attacks; (d) the growing of such crops would appear to be justifiable only when the cost of purchased protein foodstuffs is high in relation to the price of milk or the commodity sold off the farm.

(d) *Seeds Mixture and Clover Trials.*—The temporary and permanent ley trials have been continued. The investigation of the value of Arctic white sweet clover as a forage crop has been concluded. The clover was planted in May 1930, and all the plants (both inoculated and uninoculated) had died by September, 1931. During the two growing seasons the following data were obtained:—

	Total yield per acre (tons).	Yield of Dry Matter per acre (tons).	Yield of True Protein per acre (tons).	Yield of Crude Fibre per acre (tons).
1930	16	3.8	0.4	1.3
1931	26	6.2	0.6	2.1

Although a high yield of material was obtained, the fibre content is very high (33% of the total dry matter), and the yield of protein comparatively low. The material cut green was not taken readily by stock, and in certain instances it was completely refused.

(e) *Weed Eradication*.—In conjunction with the Agricultural Organiser for Herefordshire, an experiment has been started to ascertain the usefulness of sodium chlorate in the control of weeds.

AGRICULTURAL ECONOMICS.

During the past year, the work in Agricultural Economics has been continued along the lines laid down in previous years, namely, those relating to simple financial accounts. Advisory work in farm management problems has been carried out by personal visits to farmers, *i.e.*, the individual method and by the issue of periodical reports, *i.e.*, the group method.

The records show that, although in economic matters relating to farm management, it is seldom possible to adjust the internal or external organisation with any considerable degree of rapidity, nevertheless, examination over a period of 2 or 3 years, of a large proportion of the farm accounts analysed by this centre, shows that the advice is undoubtedly being acted upon.

Investigational Work.

The following summarises the investigational work being carried out :—

(a) *Costing.*

<i>No. of Farms.</i>	<i>Total Acreage.</i>
9	3,258

These may be classified as follows :—

<i>Percentage of Permanent Grass.</i>	<i>No. of Farms.</i>	<i>Type of Farms.</i>
0 — 30%	1	Cereals.
31 — 70%	2	Milk.
71 — 100%	{ 4	Milk.
	2	Mixed.

The above are being costed in full by the “Oxford” method, which entails the keeping of labour time sheets, feeding stuffs and fertilisers records, and a register of movements of live stock.

(b) *Financial Accounts.*

The Bristol Centre has always considered that the best way of advising farmers is by means of the analysis of financial accounts, and for that reason has rather specialised in this branch of work. 243 farms, comprising nearly 100,000 acres, are submitting accounts of this kind.

(c) Special Investigations.

- (1) The ascertainment of the cost of production of sugar beet on 20 farms in Herefordshire and Worcestershire has been continued during the past year.
- (2) In August last an investigation into the cost of production of strawberries was commenced in Herefordshire and Worcestershire, and steps are being taken to extend the enquiry into the Cheddar Valley, Somerset.
- (3) The special statistical investigations into mathematical correlations based on financial account data have been continued during the year and are proving satisfactory.

A new series of periodical publications is being made by the Department dealing with the application of statistical methods to farm accounting data. Three of these reports have now been made of which the first is simply a list of the farms which form the basis of the studies. The second report, entitled "*Production in Relation to Capital and Costs, 1929 Crop*," is an attempt to connect variations in production with variations in (a) capital and (b) costs, by means of simple statistical correlation methods. Tables are included giving the difference between "actual" and "calculated" production, upon the assumption that the factor of production is dependent upon the size of the capital and upon the size of the costs. The degree of correlation between production and costs was found to be very high, but that between production and capital was rather low.

The third issue of this series, entitled "*Influence of Arable upon Production*," established the change in production, capital, total costs and labour costs as the proportion of arable land varied on a farm from 0% to 60%. For example, in Wiltshire and the three counties of Gloucestershire, Herefordshire and Worcestershire, each of these factors showed a decline as the proportion of arable increased; in Wiltshire a rapid fall in costs appeared, but there was an even greater fall in production. The three counties also showed a rapid fall in cost yet with but little change in production. In Somerset, capital, total costs and labour costs all rose with increasing arable, while production was, at the same time, falling.

DAIRY BACTERIOLOGY.

232 requests for advice were received and 815 samples of milk were examined in connection with these enquiries. The total of milk samples received by the Dairy Bacteriologist from all sources was 4,723.

Clean Milk Competitions.

The Department has again co-operated with the counties concerned in the following clean milk competitions :—Gloucestershire, Somerset, Wiltshire and Worcestershire. In each case the competition was of six month' duration. In Wiltshire the competition was a small one restricted to novices, and served as a useful preliminary to entry on the Register of Accredited Producers.

The Register of Accredited Producers has been continued in Wiltshire, and the number of 54 producers on the Roll has been maintained.

Advisory Work.

The bulk of the advisory work has been in connection with milk of poor keeping quality, and taints in milk. A number of wholesale dairies are seeking advice on problems concerning the handling of milk.

Investigational Work.

Owing to pressure of work of a routine and advisory nature, it has not been found possible with the facilities available to conduct any large scale investigations. A study is being made of the methods employed in the examination of samples of milk submitted in connection with Registers of Accredited Milk Producers, in order to explore the possibilities of quicker and cheaper methods of analysis.

In collaboration with the National Institute for Research in Dairying and the Adviser in Veterinary Science, the use of an autogenous vaccine in severe outbreaks of mastitis is being demonstrated in Wiltshire.

VETERINARY SCIENCE.

The Adviser in Veterinary Science commenced his duties in Bristol on May 13th, after a special course of 8 months duration in France. During the four months work at Bristol covered by this report, 38 requests for advice have been received and 30 pathological specimens examined.

As a preliminary to future work, a survey of the most important diseases is being made with the help of information received from veterinary surgeons, farmers and Agricultural Organisers in the Bristol Province. In Wiltshire, more especially in the Swindon area, calf scour appears to be so prevalent and rapidly fatal that it is practically impossible to rear calves on many farms. Amongst cattle, the outstanding diseases are Johne's Disease, Contagious

Abortion and Mastitis. In pigs, "three weeks scour" has caused very serious losses. A considerable amount of work in connection with the diseases of sheep and poultry has been undertaken.

CIDER AND OTHER FRUIT PRODUCTS.

549 enquiries, including 224 under the Cider Instruction Scheme in the counties of Dorset, Monmouth and Worcestershire, received attention during the year.

The general character of the enquiries has been similar to previous years, though certain features have been especially prominent.

The introduction of a National Mark Scheme for Cider, by the Ministry of Agriculture, has resulted in many applications for advice on points relating to the scheme, and for examination of ciders in connection with National Mark standards. Enquiries have shown an active interest in the planting of Sweet and Bittersweet varieties of cider apples in fruit growing areas outside the recognised cider areas. These varieties are being planted with the object of utilising cull fruits from commercial crops to better advantage for cider-making. Overseas enquiries continue to increase.

The transfer of the work on Fruit Products from Campden to Long Ashton has led to an increase in enquiries under that head. The most frequent subjects of enquiry were in connection with the making of fruit wines, and the manufacture and utilisation of pectin products.

The Instructor in Cider-making paid special attention to the following points in his counties.

Utilisation of "Cull" Fruits for Cider Making. In Worcestershire, where large quantities of commercial fruit are grown in the cider districts, attention has been given to the problems of judicious blending of commercial culls with cider varieties to produce palatable beverages, and of the management of the ciders obtained by these means.

Bottling of Cider. Experiments have been continued relating to the special local problems of producing bottled ciders on the farm.

Filtering. Demonstrations on filtering were continued on farms, since this operation is essential in the production of high quality bottled ciders.

Orcharding. Further records on the Trial Cider Orchards were taken. The planting of Bittersweet varieties has been advocated.

POMOLOGY.

361 enquiries were received, of which 152 were from centres outside of the Bristol Province. Practically every phase of fruit growing was represented in the requests, the following being among the most frequent subjects dealt with : planting of new orchards, top-grafting of established trees, use of root stocks, pruning, bark ringing, raspberry cultivation, suitability of varieties of soft fruits for canning purposes.

The Pomological surveys in conjunction with soil survey work in the Evesham, Pershore and Cheltenham areas were continued.

HORTICULTURAL CHEMISTRY.

122 enquiries, including 49 from sources outside of the Province, were received.

Special investigations were continued as follows :—

1. Field experiments on "The Manuring of Fruit Trees, Bush Fruits and Vegetable Crops."

In the experiments on fruit, special attention has been devoted to the action of potassic and nitrogenous fertilisers, and in one case the effects of lime on gooseberries growing on an acid soil have been examined. Striking effects due to potash and nitrogen have been obtained at various centres. Lime was without effect.

In the vegetable experiments, the great value of potash for asparagus on an important soil area in the Evesham Vale has been established.

2. Survey of soils in the fruit and market-garden areas on the Lower Lias formation around Evesham, Pershore, and Cheltenham.

Excellent progress has been made with the mapping of the soils of the areas on a "Series" basis. The mapping of the various "clays" has been completed.

ECONOMIC ENTOMOLOGY.

The number of enquiries received during the year was 352, of which a considerable number concerned Long Ashton tar distillate wash and Pyrethrum spray fluids.

The principal investigations carried out during the year were as follows :—

Field Trials with Tar Distillate—Heavy Paraffin Washes.

Following up the successful trials against *Lygus pabulinus* in

1929-30, further field trials against both this species on black currants, and against *Plesiocoris rugicollis* on apples were carried out at a number of centres, using tar distillate-heavy paraffin washes in varying proportions. Two types of paraffin, "white" and "half white," were tested. The results against *Lygus* were again highly satisfactory. In the case of *Plesiocoris*, the tar distillate-heavy paraffin washes gave results superior to those of the "high neutral" type used alone, but failed completely at one centre, and to a large extent (on the variety Bramleys Seedling) at another. "High neutral" tar oil type wash failed to give a satisfactory commercial control at several centres.

Apple Sawfly (Hoplocampa testudinea).

It is desirable to determine the best time of application of a nicotine wash for the control of the Apple Sawfly, and experiments with this object were carried out on the apple variety Worcester Pearmain. The most efficient control was obtained by spraying the fruitlets five to seven days after blossom fall.

The Relationship of Lygus pabulinus to Markings on Apple Fruit.

Preliminary experiments carried out under field insectory conditions failed to show that the Capsid was responsible for any fruit markings. Further experiments have been arranged to obtain confirmatory data.

Correlation between the Salicin Content of Willows and Susceptibility to Insect Attack.

It has been shown that there is a correlation between the salicin content of willows and liability to attack by the Willow Beetle (*Phyllodecta vitellinae*). Possible correlations are being examined for other Willow insect pests.

Control of the Larvae of Otiorrhynchus sulcatus attacking Greenhouse Plants.

The root feeding larvae were not killed by dipping pots of infested cyclamen into Pyrethrum emulsions. Paradichlorobenzene incorporated in the potting soil provided a high measure of control, but harmed the roots of the plants.

The Spreading and Adhesive Properties of Colloidal Lead Arsenate on Willow Foliage.

One of the principal reasons for the failure of lead arsenate to provide efficient control of Willow Beetles has been due to uneven spreading of the insecticide on the foliage. Colloidal lead arsenate,

used in conjunction with the spreader Agral I, gave an excellent cover of the leaves of a large selection of willow varieties, and adhered for a long period.

The Control of the Blow-Fly of Bacon.

Experiments were carried out in the laboratory and in a bacon factory to determine the efficiency of Pyrethrum preparations as repellents to Blow Flies. Preliminary experiments showed that the active principles of Pyrethrum in a vegetable oil gave promising results.

Repellents to Insects attacking Man.

A number of repellents were investigated, and a preparation consisting of pyrethrins, incorporated in vegetable oils, was the most efficient repellent to flies, mosquitoes, midges, harvest bugs, etc.

ECONOMIC MYCOLOGY.

The number of advisory letters despatched during the year was 307, compared with 299 in the previous season.

The following is a summary of the chief diseases under investigation :—

Fruit. Die-backs of apple trees (associated with *Cytospora* sp.) ; fruit rots of apples, especially that caused by *Gloeosporium album* ; strawberry leaf spots and fruit rots.

Vegetables. Asparagus diseases (especially the control of *Rhizoctonia Crocorum*) ; “ halo blight ” of dwarf beans (caused by *Bacterium Medicaginis* var. *phaseolicola* ; diseases of leeks (especially the control of “ white tip ” caused by *Phytophthora Porri*) ; lettuce diseases ; mint rust (*Puccinia Menthae*) and its control ; parsnip canker ; foot rots and pod spots of peas ; mosaic of peas ; mosaic of marrows ; and “ potato sickness.”

Flowers. Freesia mosaic ; gladiolus corm rot ; the control of black blotch of delphiniums (*Bacterium Delphinii*).

Miscellaneous. Willow rusts and their control ; hop diseases occurring in the Province and their control (downy mildew, nettle-head, mosaic, split leaf, chlorotic disease, etc.).

DISEASE CONTROL MATERIALS AND METHODS.

132 enquiries relating to these subjects, of which a large proportion, 114, came from outside the Bristol Province, were received.

Of the total enquiries, 30 emanated from manufacturers of winter washes, 15 came from various sources overseas, and 21 concerned the use of Pyrethrum spray products.

WILLOW GROWING.

217 enquiries were received concerning problems connected with willow growing. The main subjects of enquiry were as follows :—

The control of insect and fungus attacks.

Manurial treatments and drainage operations.

Renovation of old beds.

Methods of preparation of land for planting, and varieties suitable to plant.

The cultivation of the cricket bat willow.

In the past, the inadequacy of Knapsack spraying of willows has been frequently demonstrated in Somerset, and in the present season two public spraying demonstrations were given in collaboration with the County Horticultural Superintendent, in which efficient spraying methods were shown.

Experiments have been commenced on the renovation of old beds in which the use of long sets, closely planted, is being examined.

The Somerset County Council willow beds continue to serve the useful purpose of demonstrating the local value of certain varieties. The plantings of several sorts which have proved of special value in the trials have been extended, and seedling varieties raised at Long Ashton have been added to the experimental beds.

PUBLICATIONS, 1931.

LONG ASHTON RESEARCH STATION.

Annual Report of the Agricultural and Horticultural Research Station in
the Bath and West Journal, 1930-31.

BARKER, B. T. P.

"Fruit Products and Associated Problems." (Read at Imperial Horticultural Conference, August 1930. Published in Proceedings of the 1st Imperial Horticultural Conference, March 1931).

"The Fruit Tree Complex in Relation to Environment." (Read at International Horticultural Congress, August 1930. Published in Report and Proceedings of the IX International Horticultural Congress, 1931).

"The Fungicidal Action of Sulphur." (Read at International Botanical Conference, August 1930. Published in Abstracts of Communications to 5th International Botanical Congress, 1931).

DAVIS, M. B.

"Investigations on the Nutrition of Fruit Trees. Some effects of Deficiencies of Nitrogen, Potassium, Calcium and Magnesium, with Special Reference to the behaviour of Certain Varieties of Apple Trees." (Journal of Pomology and Horticultural Science, Vol. IX, No. 1, March 1931).

JOHNSTONE, KATHARINE H.

"Observations on the Varietal Resistance of the Apple to Scab (*Venturia inaequalis*, Aderh.), with special reference to its Physiological Aspects." (Journal of Pomology and Horticultural Science, Vol. IX, No. 1, March 1931, and Vol. IX, No. 3, September 1931).

KEARNS, H. G. H.

"The Larval and Pupal Anatomy of *Stenomalus micans* Ol. (Pteromalidae), a Chalcid Endoparasite of the Gout-Fly of Barley (*Chlorops taeniopus* Meig.), with some details of the Life History of the Summer Generation." (Parasitology, Vol. XXIII, No. 3, July 1931).

MARSH, R. W.

"Apple Scab Control in the Bristol Province: Field Trials, 1930." (Journal of Pomology and Horticultural Science, Vol. IX, No. 1, March 1931).

"The Control of Apple Scab." (Read at Revision Course in Horticulture, Reading, September 1931: Published in Bull. XLI, Reading University, 1931).

OGILVIE and MULLIGAN, B. O.

"A Leaf Spot of Lettuce due to *Pleospora herbarum*." (Gardeners' Chronicle, January 10th, 1931, Vol. 89, p. 35).

"White Tip Disease of Leeks." (Gardeners' Chronicle, May 9th, 1931, Vol. 89, p. 360).

"Pea Sickness, an important Disease of Field Peas." (Gardeners' Chronicle, August 8th, 1931, Vol. 90, p. 122).

PUBLICATIONS—*contd.*

SPINKS, G. T.

"Fruit Breeding." (Read at Revision Course in Horticulture, Reading, September 1931. Published in Bull. XLI, Reading University, 1931).

SWARBRICK, T.

"Problems of Strawberry Cultivation." (Read at Revision Course in Horticulture, Reading, September 1931. Published in Bull. XLI, Reading University, 1931).

TUTIN, F.

"Note on *Kalanchoe Aleurodes*." (Gardeners' Chronicle, 4th July, 1931, Vol. 90).

"The Comma Butterfly in England." (Nature, 19th December, 1931, Vol. 90).

"Tar Distillate Winter Washes." (Read at Revision Course in Horticulture, Reading, September 1931. Published in Bull. XLI, Reading University, 1931).

WALLACE, T.

"Soil and Climate Surveys as a basis of Fruit Research." (Read before Imperial Horticultural Conference, August 1930. Published in Proceedings of 1st Imperial Horticultural Conference, March 1931).

"Factors influencing the Storage Qualities of Fruits." (Read before Imperial Horticultural Conference, August 1930. Published in Proceedings of 1st Imperial Horticultural Conference, March 1931).

"Investigations relating to Potassium Deficiency of Fruit Trees." (Journal of Pomology and Horticultural Science, Vol. IX, No. 2, June 1931).

"Manuring of Fruit Plants." (Encyclopaedia of Scientific Agriculture, October 1931, published by Ballière, Tindall and Cox).

"The Nutrition of Fruit Trees." (Read at Revision Course in Horticulture, Reading, September 1931. Published in Bull. XLI, Reading University, 1931).

"Fruit Soil Surveys and their Significance in Fruit Culture." (Read at Revision Course in Horticulture, Reading, September, 1931. Published in Bull. XLI, Reading University, 1931).

"The Effects of Leaching with Cold Water on the Foliage of Fruit Plants." (Read at Agricultural Meteorological Conference, London, October 1931. Published in Report on Agricultural Meteorological Conference, 1931).

WALLACE, T., BRACEWELL, M. F. and ZILVA, S. S.

"The Anti-Scorbutic Potency of Apples—III." (Biochemical Journal, Vol. XXV, p. 144, 1931).

WALLACE, T. and LING, A. W.

Report of Experiments on the Eradication of Bracken. (Journal of the Bath and West Society, 1930-31).

WALLACE, T., SPINKS, G. T. S. and BALL, E.

"Fruit Growing Areas on the Old Red Sandstone in the West Midlands." (Ministry of Agriculture and Fisheries Bulletin, No. 15, June 1931).

WALTON, C. L. and KEARNS, H. G. H.

"Carabid Beetles as Strawberry Pests in the Cheddar District." (Journal of Ministry of Agriculture, July 1931).

PUBLICATIONS—*contd.*

BERKELEY SQUARE ADVISORY CENTRE.

DAWE, C. V.

"Financial Accounting applied to Agricultural Economic Investigation."
(Read before Agricultural Economics Society. Published in Proceedings of the Agricultural Economics Society, Vol. I, No. 4, September 1931).

"The Economic Classification of Farms as a Basis of Agricultural Advisory Work." (Read at the International Conference of Agricultural Economists, Vol. 2, March 1931).

DAWE, C. V. and BLUNDELL, J. E.

"List of Farms." (University Bulletin—Statistical Series No. 1, February 1931).

"Production in Relation to Capital and Costs: 1929 Crop." (University Bulletin—Statistical Series No. 2, February 1931).

"Influence of Arable upon Production, 1929 Crop." (University Bulletin—Statistical Series No. 3, July 1931).

DAWE, C. V. and HAYES, G. G.

"Cost of Production of Sugar Beet in Hereford and Worcestershire, 1925/26—1929/30." (University Bulletin, No. 6).

LING, A. W.

"Grass as a Foodstuff." (Journal of the Wiltshire Association of Dairy Students, Vol. III, No. 1, January 1931).

CAMPDEN RESEARCH STATION.

ADAM, W. B.

"Lacquer Protection of Fruit and Vegetable Cans." (Food Manufacture, April 1931).

HIRST, F. and ADAM, W. B.

"Experiments on Hydrogen Swells and Perforations carried out during 1929 and 1930; with Special Reference to Storage of Cans at High Temperatures." (Supplement to Cannery Bulletin, No. 1, of the Campden Fruit and Vegetable Preservation Research Station, June, 1931).

"Varieties of Peas Suitable for Canning." (Journal of the Ministry of Agriculture, April 1931).

"Varieties of Fruits Suitable for Canning." (Cannery Bulletin, No. 3, of the Campden Fruit and Vegetable Preservation Research Station, May, 1931).

HIRST, F.

"Spoilage in Canned Foods." (Food Technology, September 1931).